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SOIL INSTABILITY IN TUNDRA VEGETATION*

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Movement of the substratum and thawing of perennially frozen ground are of primary importance in northern latitudes in controlling the microdistribution of tundra vegetation. In middle latitudes, however, soil movement receives only minor attention in studies of vegetation, except in specialized habitats. Griggs (1934, pp. 168–170) drew an analogy between vegetation of rocky arctic slopes and weeds of plowed fields of temperate regions. Raup (1947, p. 50) classified the vegetation of the Brintnell Lake region and Polunin (1934, p. 346) classified the vegetation of Akpatok Island according to habitat, rather than according to recognized ecological schemes. Polunin (1935, pp. 192–194) stated that soil movement on Akpatok Island in eastern arctic Canada has retarded the development of the vegetation since the island was freed of continental ice. Thawing of perennially frozen ground under existing climates is unique to regions of high latitudes where it has a profound effect upon local water tables, thus upon vegetation.

The effects of unstable soils upon vegetation were studied on Seward Peninsula, which extends west of central Alaska between the Arctic Ocean and the Bering Sea. The peninsula, lies between 161° and 168° west longitude and between 64° north latitude and the Arctic Circle (fig. 1).

This paper is the byproduct of field studies made during the summers of 1948 and 1949 for the permafrost program of the United States Geological Survey in cooperation with the Engineer Intelligence Division, Office of the Chief of Engineers, United States Army.

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GEOGRAPHIC SETTING

Topography

Four types of topography are represented on the Seward Peninsula: coastal plain, dissected uplands, interior lowlands, and mountains. The coast is bordered by a series of low plains, in places narrow and broken by upland prominences extending to the shore, in other places the plains are 1 to 10 miles wide. Dissected uplands occupy the southern and northern thirds of the peninsula and are characterized by rounded summits and convex slopes. Relief varies from 800 to 2,000 feet. A crescent-shaped system of mountains separates the dissected uplands. The mountains, from west to east, consist of the Kigluaik, Bendeleben, and Darby ranges (fig. 1). Summit altitudes average 2,500 feet, but some peaks exceed

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FIGURE 1. Index map of Seward Peninsula, Alaska.

4,000 feet. Valleys in the mountains are U-shaped, slopes are steep, and glacial cirques occur at the heads of most valleys. Interior lowlands are most extensive north of the Kigluaik Mountains. There relief is low, drainage is poor, and many lakes are present.

Vegetation

Most of the peninsula is treeless and is characterized by assemblages of shrubs and herbaceous plants which collectively are called "tundra." Willow shrubs, 10 to 12 feet high, grow along nearly all streams, and at sites of most ground-water seeps. Alder thickets are characteristic of steep well-drained slopes in the mountains and locally in the dissected uplands. Poplar occurs in small patches on the lower slopes in the dissected uplands and along stream valleys at the eastern end of the mountains. Spruce is found at intermediate elevations in the east and southeast sections of the peninsula (fig. 1).

Climate

The climate on Seward Peninsula is characterized by long, cold winters and short, cool, wet summers. Periods of several days to a week with temperatures below freezing alternate with similar periods with temperatures above freezing during spring and fall. The mean annual temperature at Candle, in the northeastern part of the Peninsula, is 20.2° F; the minimum temperature recorded is −60° F. The mean annual temperature at Nome, on the southwest coast, is 25.9° F; at White Mountain, within the spruce forest, 27.2° F. Minimum temperatures at Nome and White Mountain are not as low as at Candle (Taber, 1943, pp. 1440–1443; U. S. W. B. Climatic Summary, 1943). Temperatures of plants, soil, and rocks are more extreme than air temperatures recorded by the U. S. Weather Bureau, because plant, soil, and rock surfaces lose and absorb more heat than does air.

At Nome, during the summer of 1949, only 12 days were without rain in the 92 days of July, August, and September. For 35 consecutive days, August 1 to September 5, precipitation fell every day. Most of the precipitation is light drizzle of long duration, but heavy showers are not uncommon. Because of low temperatures and high atmospheric vapor pressures, evaporation rates are low.

Perennially Frozen Ground

Perennially frozen ground occurs nearly everywhere north of the mountains except under rivers and most lakes. Larger areas of unfrozen ground exist in the dissected uplands south of the mountains. For the most part, the unconsolidated deposits of the coastal plain are perennially frozen from 1 to 10 feet below the surface to bedrock, but thawed ground is present under streams. Depths of summer thawing depend upon the density and kind of vegetation cover, soil type, topography, and drainage conditions. Gravel tailing piles near Nome have become perennially frozen in 7 years from near the surface at least to bedrock at a depth of 60 feet.

Congeliturbation

Congeliturbation involves the processes that stir and mix the surface layers of soil in cold climates where freezing and thawing is intense. The material so moved is a congeliturbate (Bryan, 1946, p. 633). On Seward Peninsula it is a major geomorphic process and a dominant factor affecting vegetation. Some of the effects of congeliturbation upon the development of vegetation and upon modification of the land surface have been described by Hopkins and Sigafoos (1951, pp. 59–63).

Taber (1930) has shown that freezing silty soils in the presence of abundant moisture absorb a quantity of water in excess of the natural porosity of the unfrozen

material. The excess water is present as segregations of small clear ice lenses and stringers, and large wedges 1 to 4 feet wide and 4 to 15 feet long. Individual grains of unconsolidated deposits are cemented with ice in the interstices which are invisible to the naked eye.

The intensity of heaving or amount of movement in the soil upon freezing is determined by the abundance of clear ice formed and upon the binding effects of vegetation. Any variations in the depth of annual freeze and thaw, in the insulating effects of the plant cover, in the amount of moisture and in the thickness of snow in autumn, result in variations in the quantity of ice formed, and thus in the intensity of congeliturbation. Dilation of the soil surface layers is not uniform, and differential heaving is a general phenomenon, not an exceptional one. Congeliturbation affects all parts of the soil surface layers in depth and horizontal extent in high latitude regions.

Plants grow and develop within and on the congeliturbates while the soil is in motion. The structure and form of the vegetation is determined by the interaction of plant growth and the intensity and kind of soil movement. Congeliturbation, which sorts coarse and fine fragments in soil, acts on vegetation as well. Thus rings, nets, garlands, stripes, mounds, hummocks, and ridges, which are common microrelief features formed by frost action (Sharp, 1942b), also are common patterns in the microdistribution of plants.

EFFECTS OF CONGELITURBATION UPON VEGETATION

It is practically impossible to separate cause and effect in the interrelationship between congeliturbation and vegetation without describing the development of microrelief features in which plant growth is an important factor. Congeliturbation, however, affects plants by: (1) burying them beneath soil; (2) damaging roots and stems by breaking or bending them; and (3) by changing soil-water relations by moving the plants with respect to water table or by blocking surface-water flow. These effects result from spring and fall movement of the upper 1 to 3 feet of soil.

Congeliturbation on Horizontal Surfaces

Congeliturbation is expressed in vertical heave and horizontal thrust; on flat-lying surfaces these movements produce nearly circular patterns and mounds.

Congeliturbation breaks the turf destroying the plants, or it heaves the turf above the general surface altering the soil-water relations. Where the turf is thin or discontinuous, it is broken by congeliturbation. Where turf is thick or consists of a tight tangle of stems and roots in peat, it remains intact and is heaved upward.

Frost, scars, peat rings, tussock rings and groups, and tussock-birch-heath polygons. Frost scars, peat rings, tussock rings and groups, and tussock-birch-heath polygons form in areas where turf or peat is thin relative to the depth of annual thaw—the layer of soil subject to congeliturbation (Hopkins and Sigafoos, 1951, pp. 66–87). Formation of frost scars—"mud spots" of Washburn (1947, p. 99) and "spot medallions" of some Russian workers (Poire, 1949)—is the initial result of congeliturbation on most sites (fig. 2). Peat rings (Fleckentundra, Troll, 1944, p. 631) develop from frost scars in dense sedge sod growing on peat in wet areas where water stands around the base of the plants. Continued congeliturbation forces the marginal peat into ridges surrounding the scar, forming a ring. If the bare soil areas are numerous and close together, vegetation on the marginal ridges, forms a netlike pattern (Troll, 1944). Cottongrass plants germinate in the mineral soil adjacent to the peat ridge, and form a tussock ring. Growth of additional tussocks within the center of the ring forms a tussock group. Frost scars in areas of thin peat form centers of mineral soil upon which cottongrass tussocks grow. These low barely perceptible mounds of mineral soil are surrounded by shallow

peat-filled channels in which birch-heath grows. When closely spaced the features become tussock-birch-heath polygons. Isolated frost scars more or less continuously form over broad areas; thus the tussock-birch-heath polygons in a given area may be in varying stages of development. Low mounds of turf-covered mineral soil surrounded by wet marshy areas in Siberia, described by Nikiforoff (1928, p. 70), are unlike the tussock-birch-heath polygons on Seward Peninsula. Nikiforoff believes that the features he described are formed by the movement of moist soil upward beneath the mounds; differential freezing and thawing occurs between the mounds and the lower swampy areas. The mounds persist because of continued differential heaving. Tussock-birch-heath polygons owe their existence to the interaction of plant growth and congeliturbation.

The formation and development of these microrelief features represents the widespread importance of congeliturbation upon tundra vegetation where soils appear to be stable upon casual observation.

FIGURE 2. Dark frost scars in area of intense heaving in sedge sod; white square is 10 inches on a side.

Ground-ice mounds. Oval, elongate ground-ice mounds (Sharp, 1942a) are common in arctic, sub-arctic, and some alpine areas. Ground-ice mounds were studied near a large lake in the central part of Seward Peninsula. The mounds, 20–40 feet long and 3 to 5 feet high, are located in a sedge marsh on a sand plain bordering the lake. The mounds consist of a central core of ice overlain by a layer of sand and a tight sod mat, 6 to 8 inches thick. The sod is split for the entire length of most mounds but is unbroken on some mounds; piles of folded sod characterize sites of former mounds. The mounds are pushed upward by rapid vertical and lateral growth of ice above the perennially frozen ground, breaking the sod (Sharp, 1942a, pp. 420–422). Subsequent thawing of the ice mass, because of loss of insulation, causes the mounds to collapse. Growth and collapse of mounds occurs in one year.

The vegetation in the marsh, on the mounds with the split sod, and on the piles of folded turf is composed of the following species:

PRIMARY SPECIES: *Carex aquatilis, C. rotundata, C. membranacea, Scirpus cespitosus.*

SECONDARY SPECIES: *Eriophorum angustifolium*.[1]

Carex aquatilis and *C. rotundata* produce strong stolons which, with the roots, form a tight sod resting on coarse sand. Water stands at the bases of the plants.

On the mounds with unbroken sod, the following additional species are present: *Luzula Wahlenbergii, Betula nana* ssp. *exilis, Andromeda Polifolia*. These species grow only in habitats drier than those of the sedge marsh. Because the ice core has been preserved by the insulating properties of the sod, the mounds with the unbroken sod, then, have been in a raised position for a period sufficiently long for *Luzula, Betula*, and *Andromeda* to become established.

With the accumulation of peat, mosses such as *Sphagnum* spp. and *Pleurozium schreberi* begin to grow and additional peat is deposited. The ice of the mound is further protected from thawing, and change in the vegetation continues.

Nikiforoff (1928, p. 71) has described mounds with a form similar to the ground-ice mounds but formed in a different manner. According to him, the ground-surface layers freeze, and unfrozen ground water above the perennially frozen ground is thereby put under pressure. As freezing continues, and especially if the ground water is flowing downslope, hydrostatic pressure forces the surface to uparch. Mounds so formed may be 20 feet high; water may spurt from them. Trees are tilted at angles, and occasionally the trunks are split. Nikiforoff stated that the mounds are preserved in winter by the formation of ice within them but collapse in the following summer when the ice melts. Trees that grow on the site are usually uprooted when the mounds collapse. Nikiforoff called these mounds "water blisters."

Pingos. Large ground-ice mounds, 40 to 100 feet high, called pingos (Porsild, 1938), are common in arctic lowlands. Mounds with a somewhat similar form occur in poorly drained areas about 6 miles west of Nome in broad stream channels and lake beds near the bases of hills. The mounds are about 15 feet high, steep sided, about 20 to 50 feet long, and oval in outline. They are formed by the uparching of the surface through the growth of ground-ice creating a deep crack in the tops of some mounds. The vegetation around the mounds west of Nome is a sedge sod consisting of *Eriophorum angustifolium* and *Carex aquatilis*. Farther from the mounds and in standing water is a zone of *Equisetum limosum* and *Potentilla palustris*. The banks of the stream and lake are ringed with shrubs of *Salix pulchra* and *S. Richardsonii*. The surface of the mounds is covered with the following species:

PRIMARY SPECIES: *Arctagrostis latifolia*.

SECONDARY SPECIES: *Arctagrostis latifolia* var. *arundinacea, Calamagrostis neglecta, Poa arctica, Aconitum delphinifolium, Polemonium acutiflorum, Rubus arcticus, Sedum Roseum* ssp. *intergifolium, Trientalis europea*, and *Petasites frigidus*.

Willow shrubs grow on the sides of the mounds, but it is not known whether they were present before the formation of the mounds; it is possible they grew on the stream and lake banks before the mounds were formed and have since persisted on the mound.

Elevation of the stream and lake beds 10 to 15 feet above the water surface created a new habitat for vegetation development. The pingo vegetation is not successionally related to the vegetation of surrounding areas. Caving of the sides of the pingos along with thawing and erosion of the core will eventually destroy the feature, again initiating a new site upon which plant succession will proceed.

Peat mounds. A different type of mound develops in bogs where greater thicknesses of peat have accumulated (fig. 3). Long, irregular peat mounds stand

[1]Nomenclature is that of Hultén (1941–1949). All identifiable species were collected from every area. All species unknown to the writer and all species of critical groups were collected wherever found. Specimens are being studied and will be placed in the U. S. National Herbarium, Washington, D. C.

2 to 4 feet above the surface of many wet bogs. The vegetation of the bogs consists of a sedge sod in which are the following species:

PRIMARY SPECIES: *Eriophorum angustifolium, Carex aquatilis.*

SECONDARY SPECIES: *Scirpus cespitosus, Carex chordorrhiza, C. rotundata.* On the drier mounds a dense heath shrub is prominent, and the following species are present:

PRIMARY SPECIES: *Betula nana* ssp. *exilis, Vaccinium uliginosum, V. Vitis-Idaea* ssp. *minus, Ledum palustre* ssp *decumbens.*

SECONDARY SPECIES: *Poa arctica, Empetrum nigrum, Rubus Chamaemorus. Betula* and *Vaccinium uliginosum* form a dense shrub thicket, 2 feet high, and are the most prominent species.

The mounds begin as small hummocks of *Sphagnum;* their size is increased by the deposition of dead plant parts, which form peat, and by frost-heaving. In the small hummocks of *Sphagnum,* in addition to the sedges of the wet areas,

FIGURE 3. Dark shrub-covered peat mounds in marshy area near Nome.

grow *Rhododendron lapponicum* and *Andromeda Polifolia.* Troll (1944, pp. 633–634) has described similar mounds which, he believes, owe their height to differential growth of ice lenses in the peat because of unequal freezing of the bog surface. He stated that unequal snow cover on the surface of the bog, due to the projecting peat mounds and *Sphagnum* hummocks, causes the elevated areas to freeze more rapidly in the fall. Rapid freezing, according to Troll, causes more clear ice to form under the mounds than under the sedge of the bog, and a net rise of the mound surface results. Whether this mechanism has been the major cause of the mound formation on Seward Peninsula is not known, but a large part of the surface of bogs near Lava Lake and east of Nome has been elevated. The peat at the top of some mounds becomes dry and is removed by wind, suggesting a mechanism by which the mounds disappear. Hanson (1950, pp. 624–625) made similar observations of mounds near Kotzebue, Alaska, north of Seward Peninsula. The mounds are formed, he believes, by a number of processes, but owe their height largely to accumulation of peat. Congeliturbation and plant growth in thick, wet peat completely changes the environment and initiates conditions which result in a different succession without an accompanying climatic change. Some depressions in which peat mounds occur hold water because of perennially frozen

banks and bottoms, and may drain if the banks thaw (Hopkins, 1949, pp. 124–127), inducing additional changes in the environment.

Ridges and depressions. Ridges and depressions occur locally on river flood plains of southern Seward Peninsula. The depressions are 3 to 4 feet wide and have rocky floors 2 to 4 feet in diameter. The ridges, 1 to 3 feet wide, 2 to 4 feet high, and steep walled, surround the depressions and form a reticulate pattern. The ridges consist of a layer of peat that ranges from 6 to 18 inches in thickness overlying mineral soil. Shrubs of *Salix pulchra* and *S. Richardsonii* cover most of the surface; but in a few places the ridges support the following species:

PRIMARY AND SECONDARY SPECIES: *Equisetum arvense*, *Arctagrostis latifolia*, *Festuca altaica*, *Carex membranacea*, *Salix reticulata*, *Polygonum Bistorta* ssp. *plumosum*, *Potentilla fruticosa*, *Sedum Roseum* ssp. *integrifolium*, *Dryas octopetala* sensu lat., *Empetrum nigrum*, *Vaccinium uliginosum*, *Pedicularis* spp., *Artemisia arctica*, and *Senecio lugens*.

Griggs (1936, pp. 395–397) described "hummocks and hollows of the heath" which are similar to ridges and depressions. Griggs believes that the ridges are raised upward by the lateral force of freezing water within the depressions; the soil within the ridge does not freeze as early as the water in the depression.

The ridges and depressions appear to be the mirror image of the earth hummocks described by Sharp (1942b, pp. 282–283)[2] Earth hummocks result from the differential freezing of the mounds and the surrounding low areas. The low areas freeze first because they are wetter, forcing unfrozen soil upward under the mound. The soil profile within the hummocks shows involutions of peat and mineral soil. In areas of ridges and depressions, early freezing of the bare soil in the bottoms of the holes would force unfrozen soil into the ridges, which would still be unfrozen because of the insulating effect of the vegetation and peat. Furthermore the tight mat of woody roots and stems would resist disruption by frost heaving. What determines whether earth hummocks or ridges and depressions are formed initially is not known. Earth hummocks and ridges and depressions are additional manifestations of frost heaving and further evidence that congeliturbation is an active and important environmental factor affecting the development of vegetation.

Earlier observations on frost-heaved patterns. Huxley and Odell (1924, pp. 212–216) described polygons occurring on nearly horizontal surfaces on Spitzbergen. Cracks or fissures, resembling drying cracks in mud, outline the polygons; the centers are bare of vegetation and are marked with smaller polygonally arranged cracks. These features the authors named "mud-flat polygons," and stated that they are similar to the *Zellenboden* of German authors. Channels surrounding mud-polygons (Elton, 1927, pp. 165–166) are filled with *Dryas octopetala* and *Salix polaris* plants. The polygons' surface structure is protected from erosion by running water, so Elton believes, because the water drains through the lower vegetation-filled channels. The tight mats further stabilize the polygons by inhibiting lateral soil movement. Elton (pp. 171–172) described frost-heaved mounds of soil in areas otherwise covered with dense turf. Some mounds are 2 feet high and 15 to 20 feet across, with surfaces bare of vegetation. Smaller spots of frost-heaved soil are frequent in the areas studied; newly formed ones occur as splits in the turf.

Washburn (1947, pp. 97–99) described mud polygons from Victoria Island in northwestern Canada. The features he described are similar to the polygons described by Elton; centers consist of bare soil separated by a reticulate pattern of peat-filled channels upon which the vegetation grows.

[2]M. G. Rutten (1951, Polygon soils in Iceland. Geologie en Mijnbouw, 13: 161–167) has presented a new idea concerning the development of earth hummocks and stone nets in Iceland. Rutten's paper has only recently come to my attention; additional reference to it has not been made.

Lundqvist (1949, pp. 335–336) has classified surface features formed by congeliturbation according to amount of plant cover, boulder content of the soil, and degree of slope. On horizontal surfaces free of boulders, earth hummocks are formed when plant cover is heavy. Polygons, similar to the mud polygons of Elton, are formed on horizontal surfaces when plant cover is meager; these are termed "fissure polygons" by Lundquist. Hopkins and Sigafoos (1951) have shown that the type of plant cover, the method of plant reproduction, and the form of the plants are as important as the amount of cover in determining the form of the congeliturbate.

Congeliturbation on Slopes

Soil masses of varying size are moved downslope forming a variety of microrelief features. Steep slopes are characterized by small quantities of fine material and an abundance of coarse rock fragments. Downslope movement forms rock stripes alternating with thick mats of plants or with soil stripes. The thick plant mats block the downslopes movement of rock. Gentler slopes are characterized by lobes and terraces; terraces occur on slopes of lesser angle with greater accumulations of silt (Sigafoos and Hopkins, 1951). The vegetation on the slopes inhibits frost-heaving and thrusting and modifies and diverts downslope movement.

Vegetation Stripes. Sliding of coarse and fine materials on 30° slopes of weathered calcareous schist on the Seward Peninsula forms contrasting stripes of plants and rubble. The schist weathers into silt, coarse sand, and platy fragments which range from 1 to 12 inches in long dimension. The coarse and fine materials are crudely sorted into stripes parallel to the maximum angle of slope. The striping is accentuated by plants that grow in the fines and block the downslope movement of the coarse fragments. The silt moves downslope faster than the stones and overrides or pushes aside any stones that might be across the soil stripe (Sharp, 1942b, pp. 295–296). In vegetation stripes in calcareous schist, platy rock fragments move downward as a veneer over the entire slope with little sorting. Mats of *Dryas octopetala* ssp. *Hookeriana*, rooted in buried mineral soil and broken rock, form a dam against the movement. The mats are usually about a foot across at the upslope end, and narrow gradually or are broken into thin streamers downslope. Beneath the mat is a 1- to 5-inch layer of peat. Buried stems of *Dryas* extend upslope, acting as cables holding the aerial part of the plant in position; thus the mat acts as a barrier to downslope movement, causing the rock fragments to be slowed or diverted. Around the mats are the following species: *Carex glacialis*, *Silene acaulis*, *Smelowskia calycina* ssp. *integrifolia*, *Parrya nudicaulis*, *Papaver Walpolei*, *Saxifraga oppositifolia*, *Androsace Chamaejasme*, and *Artemisia senjaviensis*.

Burial by rock and pressure of stones kills the branches growing from the upslope part of the mat. The plant grows at the apex on the downslope side so that the mat slowly moves downhill. The scanty vegetation on this slope is constantly in a state of change; plants on the upslope end of the mat are destroyed while plant invasion takes place on the downslope end. If the *Dryas* stems break, the entire mat would suddenly slide downhill, destroying all of the plants. Raup (1947, pp. 54–55) described a similar habitat on weathered shale in the Brintnell Lake area, but some different species are involved.

Turf-banked terraces. On nearly smooth, convex slopes of less than 10°, weathered calcareous schist forms small turf-banked terraces similar to those described by Antevs (1932, pp. 56–61). The terraces are 1 to 3 inches high and 12 to 24 inches across. The scarps slope at angles ranging from 30° to 60°; the bare surfaces are gently sloping to nearly horizontal. The vegetation forms a mat on the low scarp, blocking the slow downslope movement of soil and fine rock debris. Plants characteristic of the mats are:

PRIMARY SPECIES: *Dryas octopetala* ssp. *Hookeriana, Carex glacialis.*

SECONDARY SPECIES: *Silene acaulis, Smelowskia calycina* ssp. *intergrifolia, Parrya nudicaulis, Papaver Walpolei, Saxifraga oppositifolia, Androsace Chamaejasme,* and *Artemisia senjavinensis.*

Beneath the centers of some mats covering the scarps is a layer of peat and humus 1 to 2 inches thick, but toward the edges of the mat, at the top and bottom of the low scarp, the stems of the mat rest directly on mineral soil. Solitary aerial stems of *Dryas* extend a few inches across the surface of some of the terraces, indicating that the rate of plant growth is faster than the disruption of the turf by congeliturbation. Under other terraces buried layers of humus indicate that congeliturbation has moved soil over the turf. Splits through the turf and into the soil indicate contraction of the soil by freezing. These splits kill many plants and create bare areas which are enlarged by congeliturbation.

Within an area with a radius of 5 feet all stages of development can be observed. Plants may be growing out over bare soil, the turf may be partially buried, and one terrace may slope directly to the next below through a break in the turf bank. The vegetation of the entire slope is unstable, though it appears more or less stable in any one spot. Downslope movement is slow, but sorting of mineral soil is continuous on a small scale, forming miniature stone and soil stripes on the surfaces of the terraces. These stripes measure 1 to 3 inches across and extend across the top of the small terraces parallel to the maximum angle of slope. Only the upper 1 to 3 inches of the soil moves downslope; turf banks are effective in modifying and diverting the movement. Huxley and Odell (1924, p. 225) believe that mats of vegetation can hold stones in stone stripes and form a rampart retarding downslope movement.

Terrace forms. Soil lobes, lobate terraces, soil terraces, and tundra mudflows were discussed by Sigafoos and Hopkins (1951). Movement of weathered materials downslope in tundra regions occurs mostly by congeliturbation and viscous flow. Rates and mechanics of movement and the resulting microrelief features depend upon the material, slope, amount of water available, and the type and density of plant cover. Isolated lobes form on steeper slopes mostly by viscous flow of nearly fluid soils. Viscous flow in spring, and creep by freezing and thawing in autumn, move soil on gentler slopes forming lobate terraces and soil terraces. Sudden spewing of fluid soils in mudflows moves material as much as several hundred feet downslope.

Creep and viscous flow are most effective in areas of bare soil and thin turf, because the ground cover only slightly restrains the moving soil. Soil moves slower in areas of thick turf and peat. Hanson (1950, p. 614) believes that ". . . seepage water, the flow capacity of the silt layer, and the weight of the water-saturated peat . . ." are important in moving materials downslope. Sigafoos and Hopkins (1951) believe that these factors, especially peat heavily weighted with water, are of less importance than are movement by freezing and thawing and by viscous flow of soil in areas of thin turf. They found that an increase in water content of soil can only increase the rate of viscous flow, because, by creep, wetter soils do not move faster than do drier soils. Viscous flow is most effective during wet spring thaws; and contrary to Hanson's hypothesis, movement is faster under thin turf. Peat is still frozen at a shallow depth and is bound in the surface layers by roots and stems of plants during the short time that viscous flow is effective. Washburn (1947, pp. 91–93) accurately measured the movement of a lobe on Queen Victoria Island, Canada. He found that stakes placed in the ground in June moved 1½ inches downslope in one month and a total of 1¾ inches in seven months from June to January.

Only lobate terraces will be discussed to show the effect of congeliturbation on slopes upon vegetation development. These terraces are characterized by

festooned escarpments on slopes ranging from 7° to 20°. They consist of sloping steps or terraces of soil mantling the bedrock; at the terrace scarps and just above them the soil is relatively thick, varying from 4 to 6 feet, its thickness depending upon the height of the terrace. Below the scarp, the soil is thinner, and bedrock lies at depths ranging from a few inches to 2 feet. The vegetation of the surfaces and scarps of the terraces is a complex assemblage: *Festuca altaica*, *Dryas octopetala* ssp. *punctata*, and *Cassiope tetragona* are most abundant. Fifty to 75 species comprise those of secondary importance. On the face of the scarps and below them is a scattered stand of shrubby willows, 2 to 4 feet high, *Salix pulchra*, *S. Richardsonii*, and *S. glauca* varieties. With the willows, *Potentilla fruticosa* and *Spiraea Beauverdiana* are common. Many of the willow stems extend out from under the lobes as though the soil had over-ridden the shrubs. The surfaces of the terraces are hummocky, marked with cracks, folds of turf, numerous spots of

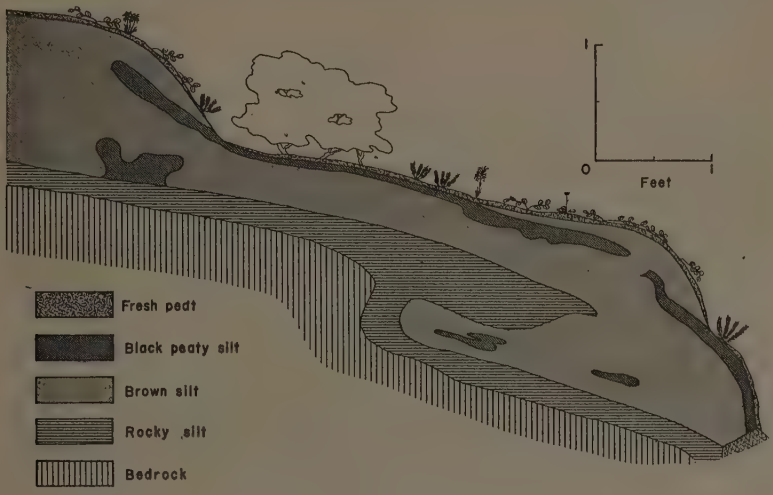

FIGURE 4. Section through solifluction lobe, shore of Lava Lake.

bare soil, and small, poorly defined stone-rings, all of which are sites of intensive congeliturbation. On sides of hummocks and faces of scarps the underground stems of the matted, woody plants extend upslope, indicating that the terminal portions of the stems have been pushed or have dropped down the slope. Buried layers of humus and peaty soil occur in the terrace (fig. 4). Taber (1943, pp. 1460–1463) has described similar terraces and discussed their formation. He believes that such terraces exist because downslope movement of soil is retarded by the vegetation mat.

Downslope movement of soil in lobate terraces occurs by frost-heaving with burial of vegetation at isolated spots. Farther downslope, the turf is broken at widely spaced intervals; increased congeliturbation enlarges the spot by pushing the turf aside. Bare soil adjacent to the turf on the downslope side moves over the plants and buries them. On the upslope side of the terraces, the vegetation is discontinuous because congeliturbation is active, the soil is thin, and weathered bedrock is exposed at the surface.

Around the bare spots the plants are being destroyed or are advancing. The entire turf usually does not move downslope as a blanket, because the plants are

firmly rooted in the soil and only part of the surface soil moves at one time. Thick layers of turf may be moved slowly downslope intact by heaving in an area a few tens of feet in diameter. The habitat, then, is one of alternating stability and instability; it is more or less stable where congeliturbation is less active and unstable where congeliturbation is intense.

Eakin (1916, pp. 78–82) described large terraces in the higher altitudes in west-central Alaska; these he called "altiplanation terraces." Similar features occur in the mountains of Seward Peninsula, especially around the lake at the head of the Kuzitrin River (fig. 1). The scarps, 10 to 25 feet high, are composed of large boulders. The surfaces of the terraces are broad, gently sloping, and range in width from 100 to 500 feet. The terraces described by Eakin are considerably larger; the blocks in the scarps measure 1 to 12 feet in diameter. Eakin believed that the terraces are formed by movement of boulders outward from the surface by congeliturbation and gravity; the fine materials of the surface are stirred by congeliturbation, and readjustment to forces of gravity causes the surface to form a gentle slope.

Other types of mass movement of soil on slopes have been described. Capps (1940, p. 169) described slow soil flow on slopes in central Alaska. He believed that the soil moves in mass down the slope. Because the movement is slow, the vegetation mat inhibits the movement resulting in the formation of terraces. Rapid flows occur, according to Capps, when the soil is extremely wet and the vegetation mat is broken by the great weight of the soil. Smith (1910, p. 97) described solifluction lobes on the uplands of Seward Peninsula. He believed that they are formed by downslope movement of soil in mass due to accumulated pressures of the weight of wet soil. Low slopes and high resistance, according to Smith, prevent the movement from being more rapid.

Swales. The formation of low ridges on poorly drained low-angle slopes and in sod-filled drainage lines affects the development of vegetation. Poorly drained gentle slopes are common northeast of Imuruk Lake; plant cover is dense, and perennially frozen ground is 6 to 18 inches below the surface. Well-defined drainage lines are absent on the summits of the hills and upper parts of the slopes. Water occurs at the surface and drainage lines occur on the lower parts of these slopes as well as on the steeper slopes of lower hills between Imuruk Lake and Lava Lake. The vegetation on the poorly drained summits, upper slopes, and in the drainage lines is a dense sod, overlying a 1- to 10-foot layer of peat. *Eriophorum angustifolium* and *Carex aquatilis* are of primary importance in the sod.

In drainage lines several tens of feet across and on upper slopes, low ridges extend roughly parallel to the contour. The exact mechanism of the formation of the ridges is not known, but they appear to be due to slow downslope movement of the sod. Gravity acting on sod resting on viscous underlying peat, and expansion of sod and peat in the wet areas between the ridges upon freezing, would result in downslope movement of the sod thus forming ridges. The following species are prominent on the ridges.

PRIMARY SPECIES: *Carex aquatilis, Salix pulchra.*

SECONDARY SPECIES: *Salix* cf. *flagellaris, Betula nana* ssp. *exilis, Rubus Chamaemorus, Rhododendron lapponicum, Vaccinium uliginosum, Ledum palustre* ssp. *decumbens,* and *Andromeda Polifolia.*

Willow thickets. Dense thickets of willows occur on steep banks of streams and lakes; their distribution accentuates the effects of slope movement. The willows are much branched, 6 to 12 feet tall, and form dense tangled thickets. The larger stems, 2 to 4 inches in diameter, are twisted and bent. They lie on or just below the surface on the ground, and small roots grow from scattered nodes. The shrubs appear to be resting on the surface of the soil. The following species comprise the thickets.

PRIMARY SPECIES: *Salix pulchra, Petasites frigidus.*

SECONDARY SPECIES: *Arctagrostis latifolia, Poa arctica, Salix alaxensis, Polemonium acutiflorum, Rubus arcticus, Spiraea Beauverdiana, Potentilla fruticosa.*

The thickets generally occur in slight depressions or reentrants in the banks and from a distance appear to be inhibiting soil movement on the slope. The willow thickets may grow, however, in a relatively stable depression, and active congeliturbation in adjacent areas may inhibit their spreading onto unstable soils. Of the above list, *Rubus, Spiraea, Potentilla,* and *Petasites* are the prominent plants on most better-drained slopes where congeliturbation or other soil disturbance is active.

THAW LAKE CYCLE

Local water tables are determined in many areas of deeply frozen silt by the proximity of perennially frozen ground to the surface. Lakes, ponds, streams, and swamps that owe their existence to perennially frozen banks are widespread on nearly level surfaces and on gently rolling uplands of Seward Peninsula. Such bodies of water are widespread elsewhere in northern Alaska where Black and

FIGURE 5. Thaw lake near Nome. Opposite shore is caving. *Eriophorum angustifolium* and *Carex aquatilis* are moving into lake in foreground. Opposite bank is 5 feet high.

Barksdale (1949, p. 116) estimated that 10,000 lakes occur in 25,000 square miles. Thawing of perennially frozen ground results in sudden changes in soil-water relations due to the collapse of soil because of the melting of ice masses. Sudden changes in soil-water relations have catastrophic effects upon plants.

Origin and Development

Small ponds that develop in areas of deeply frozen silt on Seward Peninsula (Hopkins, 1949, p. 124) are initiated by (1) disruption of plant cover by congeliturbation and (2) accelerated thaw under pools in streams and on uplands. Wallace (1948, p. 180) believes that some thaw lakes in eastern Alaska are initiated when the vegetation cover is broken by overturning of trees. Lakes enlarge by continued thawing and caving of their banks. Some lakes are slowly migrating by caving of their banks on one side and filling by encroachment of vegetation on other sides (Hopkins, 1949, p. 127) (fig. 5). By studying annual rings of trees tilted by receding banks, Wallace (1948, p. 179) calculated that banks of lakes in eastern Alaska cave at a rate of 2.3 to 7.5 inches per year.

Vegetation

The vegetation around the small lake 4 miles north of Imuruk Lake (fig. 1) will illustrate the close correlation between vegetation types and soil-water relations. It is migrating downslope toward the southwest by caving on one side, by thawing of the bottom, and by filling with vegetation, peat, and sand on the other sides. The lake level is maintained by the banks that are perennially frozen within 10 inches of their surfaces. The insulating effect of thick peat maintains the shallow depth of thaw. A tight sod, across which the lake drains, effectively prevents erosion of the underlying thawed mineral soil and peat.

The vegetation surrounding the lake is best correlated with the drainage conditions of the soil, which are determined in part by the site location in relation to the lake surface. Vegetation on a few high banks, 10 to 15 feet above the water, is cottongrass tussock-birch-heath. On the lower banks around the lake is a sedge sod. On the downslope side, or lower surface of the hill on which the lake is located, are the following species:

PRIMARY SPECIES: *Carex aquatilis, C. rotundata, C. membranacea.*

SECONDARY SPECIES: *Eriophorum angustifolium, E. vaginatum,* ssp. *spissum, Betula nana* ssp. *exilis, Vaccinium uliginosum, V. Vitis-Idaea* ssp. *minus, Ledum palustre* ssp. *decumbens.*

The secondary species, some of which comprise the cottongrass tussock-birch-heath community, occur as scattered clusters or rings of tussocks on low, broad, barely perceptible mounds of mineral soil within the marsh. In this marsh, the sedge sod overlies peat ranging in depth from a few inches to more than 2 feet. Frozen ground in late July 1948 occurred at depth of 12 to 24 inches. On the upslope side or younger surface of the hill, which recently emerged from the lake, the following species are present:

PRIMARY SPECIES: *Eriophorum angustifolium, Carex aquatilis, Salix* cf. *flagellaris.*

SECONDARY SPECIES: *Saxifraga Hirculus, Potentilla palustris, Pedicularis* ssp.

The peat is 2 to 4 inches thick overlying sand derived from granite; perennially frozen ground occurs at depths of 20 to 60 inches.

When thaw lakes and ponds drain suddenly because of rapid thawing of their banks or bottoms (Hopkins, 1949, pp. 126–130), water relations of the soil and depth of annual thaw are changed in the area surrounding such a lake. Wet sedge marshes are drained, and the vegetation dies; communities favored by drier, better-drained soils become established. Cottongrass tussock-birch-heath communities is replaced on the higher banks by willow-birch shrub. The change in vegetation would further affect the depth of annual thaw.

The zonation of communities around thaw lakes, contrary to beliefs of Kellogg and Nygard (1951, pp. 35, 81), less represents upland plant succession than does zonation around ponds in temperate regions (Gleason, 1926, pp. 21–22). No genetic relationship exists between zones in the water of the adjacent caving banks, so that vegetation on banks is not successionally related to that in the water. Much of the vegetation in water along steep banks is that which has just caved with peat and soil. This vegetation is about to die and is not the initial stage of upland vegetation.

Thaw lakes, filled thaw lakes, and thaw sinks are common and widespread in the area around Imuruk Lake (Hopkins, 1949, p. 124). They occur on flood plains, on stream and lake terraces, and on areas mantled with silty mineral soil to depths of 10 to 20 feet. They are most abundant on level surfaces, but occur on slopes as steep as 5°.

The total amount of land surface modified by the thaw-lake cycle in regions of perennially frozen ground is not known. Thawing of at least some part of the banks of nearly all lakes and major streams occur, and it is an environmental

factor that should be considered in vegetational studies. Further botanical and geological studies may show that the development of thaw lakes is one of the more important geomorphic processes modifying the land surface in areas of perennially frozen ground.

ENVIRONMENTAL DISTRIBUTION OF EFFECTS OF CONGELITURBATION

Peat rings, tussock rings, tussock groups, peat mounds, pingos, ground-ice mounds, swales, and some willow thickets develop on the wettest fine-grained soils that occur on broad, poorly drained terraces and uplands, gentle slopes, and parts of river flood plains. Swales and willow thickets occur where surface drainage in summer is concentrated. The remaining features characterize nearly horizontal surfaces, where runoff is extremely slow.

Tussock-birch-heath polygons, terrace forms, ridges and hollows, and some willow thickets develop on better-drained fine-grained soils. Tussock-birch-heath polygons form on better-drained interfluves of gently sloping uplands underlain with wet, silty soils. They are associated with the features that occur on the wettest soils. Terrace forms develop in shallow deposits of silty soil and rock that mantle well-drained slopes. The soils are generally drier than those in which tussock-birch-heath polygons develop but are wet locally during part of the thawing season. Some willow thickets grow on better-drained steep river and lake banks underlain by silty soils. Ridges and hollows form on better-drained areas of river flood plains adjacent to and within willow thickets that line the banks.

Turf-banked terraces and vegetation stripes form on the best-drained slopes on hills where bedrock is close to the surface and in terrace gravels. Turf-banked terraces form on the more gentle slopes where some fine material has accumulated, and where movement of soil is slow. Vegetation stripes reach their best development on slopes of 30° upon which movement of platy fragments is rapid and only small quantities of fines have accumulated.

Thaw lakes and accompanying phenomena are abundant on lowlands and gently rolling uplands underlain by thick, perennially frozen silt.

An almost infinite number of different microrelief features formed by congeliturbation occur in tundra regions. The effects of unstable soils on vegetation described are typical of much of the tundra vegetation of Seward Peninsula; all habitats with the possible exception of sand dunes and beaches exhibit evidence of soil movement. Microrelief features involving only fine and coarse rock materials are abundant.

CLIMAX VEGETATION PROBLEM

Discussions of the validity of the climax concept in vegetation as advanced by Clements are abundant in the literature (see Just, 1939). The climax is that stage of vegetation that is stable; its characteristics result from the effects of climate upon the available species. The generally accepted understanding of the "climatic" climax was stated by Cain (1939, pp. 150–152) to be that ultimate stage of vegetation that is limited only by the effects of climate on the plants and that will be reached regardless of differences in topography, soil, and microclimates. True climax will be reached only after the sites have been made nearly uniform by geomorphological change through geologic time (Cain, 1947, p. 193). It is believed by many, according to Cain (1947, p. 192), that edaphic and physiographic climaxes are merely stages in the vegetational development toward the true climax of the region. Edaphic and physiographic climaxes owe their existence to the limitations imposed by local variations in soil, microclimates, topographic position, and history of the area upon the hereditary potential of the plants.

These concepts carry a number of assumptions pertaining to the interrelationship between the land surface and vegetation: (1) the substrata are stable or undergoing only slow, uniform, and unidirectional changes (Gleason, 1917, p. 479), (2) succes-

sion results from slow change in the substrata or from changes in the habitat due to the growth of the plants, and (3) changes in the land surface are slow in terms of the life of the plants. These assumptions are invalid in at least the treeless areas of high latitudes. Substrata are unstable; the upper layers undergo constant churning by freezing and thawing greatly masking slow unidirectional changes. Succession, starting on bare soil, is frequently repeated because constant churning periodically destroys the plant cover. Much of the vegetation is in the initial stage so that the plants have reacted too little upon the habitat to affect much change in "forming a seed bed." Furthermore, individual plants are locally separated by bare soil, so that they have little affect upon one another (Raup, 1947, p. 49). On nearly all sites the plants are of first generation and only at isolated sites do they die of old age or because of unsuccessful competition with succeeding species.

The temporal nature of most microrelief features must be understood, for many are so short-lived that their destruction may occur during the time that the initial plant cover is becoming established. The relatively stable sites are restricted in areal extent and of little significance in the entire botanical landscape. They too are subject to sudden change in regional geomorphic development. Some of the most stable sites in high latitude regions are on stream banks which are, in temperate regions, among the most unstable sites (Raup, 1950, p. 12). Thaw lake phenomena are examples of these types of sudden changes. The vegetation associated with the more or less stable features cannot be thought of as climax for the region because the region will not develop characteristics of the stable sites.

Vegetation of high latitudes must be described and understood in terms of the unstable substratum; and climax concepts should not be used. It is merely an academic exercise to state that certain vegetation in treeless areas of high latitudes is "climax." The vegetation on each site is in equilibrium with geomorphic processes which vary in intensity according to the site, so that most vegetation types are in successional systems unique to themselves and unrelated to each other.

Listing the zonation of communities about ponds or on uplands in order to describe succession is invalid because of different history, process, and soil characteristics at each site. Raup (1941, pp. 219, 232–238) discussed this problem as well as others in describing plant succession in boreal vegetation. He noted also that no two lists of species from different sites are the same, although, from all outward appearances, the habitats are equivalent.

CONCLUSIONS

Congeliturbation and the thaw-lake cycle have been effective in modifying the botanical landscape since before the last glacial maximum. It is likely that the present vegetation of part of the Seward Peninsula is similar to that which grew in ice-free areas of the peninsula during maximum ice advance. Flint (1947, pp. 455–456) quoted estimates of the reduction of the mean annual temperature during the glacial maxima for several areas; the estimates range from 9° F to 14° F. The present mean annual temperatures recorded by the U. S. Weather Bureau, range from 20.2° F at Candle to 27.2° F at White Mountain. The weather recording station at Candle is close to several buildings in a protected valley; undoubtedly a great many areas on Seward Peninsula are characterized by mean annual temperatures lower than that at Candle, so that the range in mean annual temperatures on the peninsula is at least as great as the estimated reductions for the glacial maxima. Therefore, mean annual temperatures during maximum ice advance were present in ice free areas on the peninsula. Furthermore, persistent banks of snow and nèvè exist in cirques in the Kigluaik and Bendeleben Mountains;

yet vegetation similar to that described in preceding paragraphs occurs on many of the adjacent slopes and valley floors. The "phytoclimate" of the peninsula north of the mountains at the present time cannot be much different from periglacial climates on Seward Peninsula. Lakes remain frozen well into June, first frost probably occurs in late August, and snow banks persist throughout the year in protected coves on all north-facing slopes and on other exposures as well. All of the vegetation seen on the peninsula, except spruce and poplar forests, occurs near the severe habitats of the mountains.

Recent work has shown that intense congeliturbation disturbed the soil in parts of United States during glacial periods (Smith, 1949; Denny, 1950; see also Jour. Geol., 1949, 57 (2)). How intense soil movement in low-latitude periglacial regions was during the glacial maxima is not completely known.

In regions where congeliturbation has been active, a recorded change in vegetation does not necessarily mean a change in climate. It is possible that some of the changes in vegetation recorded in bogs about the termini of the last ice sheet are due to the effects of periglacial congeliturbation and thaw-lake phenomena. Further investigation may show that the movement of the soil must be considered in all studies pertaining to post-glacial plant migrations.

SUMMARY

The form and microdistribution of plants and the development of vegetation in a climate producing perennially frozen ground are greatly affected by congeliturbation, or stirring of the soil by freezing and thawing. The vegetation does not reach "climatic" climax because of the actively moving substratum, whether it is peat, soil, or rock. New concepts of vegetational development must be considered if a true picture is to be had.

Congeliturbation on horizontal surfaces forms circular or polygonal patterns and mounds that rapidly alter the environment, causing variations in many other edaphic factors. Many surface features have forms characteristic of this process.

Congeliturbation on slopes moves masses of soil and rock downslope, forming stripes and terraces. Growth of plants on these sloping sites is greatly affected.

Many lakes and ponds in areas of perennially frozen ground are short-lived, owing their existence to frozen banks. Many of the lakes suddenly drain when the perennially frozen ground thaws. Drainage of the lakes lowers the local water table, greatly affecting the vegetation.

The vegetation on the Seward Peninsula during the maximum glacial stages probably was similar to the present vegetation.

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The Ohio Journal of Science will make an award of $150 for an outstanding paper in the field of chemistry received before January 1, 1952. Further details may be found on page 168 of the July, 1951, number of the Ohio Journal of Science.

MASS-WASTING, CLASSIFICATION AND DAMAGE IN OHIO

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The sudden and often spectacular free fall, slide, flow, creep or subsidence of earth materials may be costly in terms of human lives and property damage. Phenomena of this type, variously called "landslide, earthflow or subsidence" are assigned by geologists to gravity controlled movement or referred to collectively as "mass-wasting." This category also includes movement of dry or hard-frozen masses, or snow-laden debris when moved by gravity. Figure 1 illustrates some of these types of movement.

This paper is intended to bring to the attention of laymen and professional men the importance and widespread occurrence of these destructive forces. A brief discussion of damage, origin, prevention and classification is presented, followed by examples in Ohio. It is hoped that the suggested classification will prove useful as an aid to the recognition of different types of mass-movement.

Annually, many highways are blocked or destroyed, soils are ruined and buried in rubble, forest lands are ripped apart, and bridges, dams, buildings and other structures are wrecked or buried by landslides. Every year, especially in southern and eastern Ohio, many thousands of dollars are lost because of this type of calamity. There is scarcely a spring which does not bring reports of landslides in the local press. It seems obvious that this is a subject of grave concern to construction engineers, soils experts, conservation men and many others including the tax paying citizen. Wherever there are slopes that are steep enough, and wherever there is loose rock material, mass-wasting is a potential threat. Such conditions in Ohio are widespread and examples of damage of one type or another are quite common.

Some of the more costly slides or flows are geologic events that occur naturally, the results of heavy rains, earthquakes or erosional processes, and others are the results of man's activities, i.e., poor engineering practice. Most people associate landslides with mountain areas, but not all occur in regions of great relief. Ideal situations are found along the steeper banks of Ohio's river valleys and on the steep slopes of mature terrain in southeastern Ohio. In many of these areas landslides and mudflows locally plague construction engineers when they fail to pay proper attention to the basic principles governing gravity phenomena.

The ingredients for a landslide or related movement are waste rock or rock materials, water, and gravity. The water increases load and, where an unstable slope exists, serves as a lubricant aiding movement. Add the force of freezing and thawing, which expands and contracts the materials, and a sufficiently steep slope where gravity can move the debris and the stage is set for creep, mudflow, or a landslide. Disturbance of vegetative cover, i.e., overgrazing or overcutting, in forested areas may hasten the approach of landslide producing factors. It is difficult to overemphasize the role of water and the fluctuation of temperatures, however, in the development of gravity movement.

Areas subject to earth movement usually have definite visual evidence of past slides, flow, or creep. Irregular hummocky areas and a line of depressions at the base of slopes of 25° or more reveal landslide topography, and a tendency towards future movement exists. Usually a concave slope profile occurs at the top of such a slope and a convex profile appears at the bottom or toe of the hill. The former is the slide surface and the latter is the bulge formed by displaced materials. If the materials involved are clay or fine silt, then slopes as small as 15° or less are susceptible to mass-movement; in fact, clay and silt will flow much like water if

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sufficiently wet. Trees, fence posts, or telephone poles standing at rakish angles suggest creep or former slides.

Prevention or control of the dangerous types of mass-wasting is a subject which deserves more attention. Since gravity, water, and frost action are the three major elements involved in most of the foregoing types of earth-movement, these should be the point of attack. Water control offers the best possibilities. Proper installation of drainage systems in an area subject to earthflow and slides is essential. Remove or lower the water content and half the battle is won. Lack of water as a lubricating agent and as a source of added weight on an unstable slope should help prevent trouble.

Where slopes are to be developed in connection with routes of travel or structures, where extensive fill is contemplated, and where excavations or cuts in solid

FIGURE 1. An idealized landscape representing several types of gravity movement.

rock are contemplated, early consultation with an experienced field geologist is strongly recommended. A careful evaluation of the mass-wasting potential should be the first step. Properly constructed retaining walls may help in some areas, but even these are sometimes overwhelmed by the power of mass-movement. When the problem concerns erosion of a river bank by undercutting, adequate control of slides may lie in suitable control of the river's lateral sweep.

Early recognition of mass-wasting potential and remedy may lie in the proper consideration of the kind of material, size and condition (i.e., wet, dry or frozen), and the relative speed of movement which could be attained upon the slopes involved. A systematic method of recognizing and classifying types of landslide phenomena is provided in table 1. One should observe the kind of material, relative size, condition and potential speed of movement, then match these data with table 1. It is believed that a little effort will enable the average person to use it to advantage, especially after reviewing the following analysis.

Rock fall is at the top of the list in table 1. It involves larger blocks of angular rock which may fall freely through the air from a rocky cliff to the ground below (fig. 1a). The accumulation may be called talus. *Rock slide* simply refers to the same type of material when it slides along a steep slope (fig. 1b).

Talus- and *rock-creep* are terms applied to smaller rock fragments, usually cobbles, boulders and some finer material which may slide, or creep with slow movement downhill (fig. 1c). Such heaps of debris travel with an imperceptible motion.

Steep rocky walls anywhere are subject to rock fall, rock slide, and talus- and rock-creep. When the rocks are layered, stratified, or jointed, by vertical or horizontal systems, they are subject to weakening by weathering and erosion.

TABLE 1

Classification of landslide phenomena

Kind of Material	Size of Material	Condition of Material	Relative Speed of Movement	Term Applied to Phenomena
Blocky, angular rock	Cubic foot or larger	Wet, dry or frozen	Fast: free fall or slide	Rock fall or Rock slide
Blocky, angular rock with snow	Cubic foot or larger	Wet, dry or frozen	Fast: free fall or slide	Debris fall Avalanche Debris slide
Cobbles, pebbles and soil	Less than a cubic foot to rock flour	Wet, dry or frozen	Rapid slide	Slump slide
Cobbles, pebbles and soil	Less than a cubic foot to rock flour	Wet	Visible flow	Earthflow
Fine silt and clay	1/16 mm. and less	Wet	Visible flow	Slumgullion flow Mudflow
Fine silt and clay	1/16 mm. and less	Wet or semi-frozen	Imperceptible flow or slide	Solifluction Soil Creep
Blocky, angular rock	Usually cobbles and boulders	Wet, dry or frozen	Imperceptible flow or slide	Talus creep Rock creep
Cobbles, pebbles and soil	Less than cubic foot to rock flour	Wet, dry or frozen	Rapid drop to imperceptible subsidence	Sink Wallow Slump depression Compaction depression

During the fall and spring seasons, water penetrates the weakened layers or openings, and freezing sets up a powerful wedging action which rips slabs from the rocky outcrops. These masses of rock and rock material fall, slide or creep down to lower levels.

Debris fall and *avalanche* or *debris slide* are all closely related. Such mass-movement consists of rapid fall, or sliding of a mixture of loose rock debris and snow. Sliding snow or a rolling rock may initiate this sort of movement, which is usually restricted to high altitudes in mountainous regions.

Mass-wasting is an important valley widening process and works closely with the vertical down-cutting action of running water. Along Ohio rivers, *slump slides* occur where the water undercuts an outer bank along a bend (figs. 1e, 2, 3).

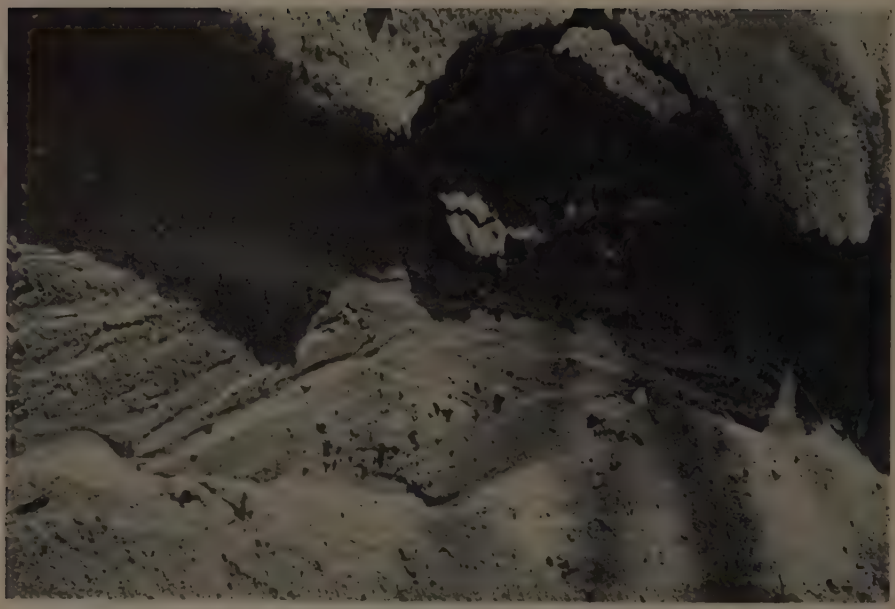

FIGURE 2. Slump slide in erosion channel, new filled section.

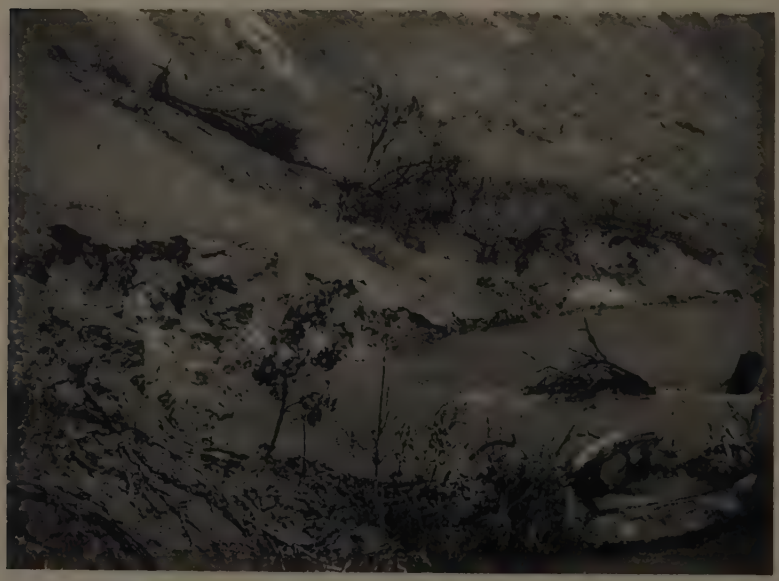

FIGURE 3. Slump slide on undercut bank, Cuyahoga River, north of Akron, Ohio.

FIGURE 4. Earth and mudflow destroying wooded section, Macksburg, Ohio. Note trees set askew, and convex slope on toe of flow.

FIGURE 5. Mudflow associated with earthflow, Macksburg, Ohio.

The sapped bank slumps and slides into the stream and is carried away. Thus the valley grows in breadth.

Earthflow is frequently associated with the foot of a *slump slide* where the latter occurs on hill slopes (fig. 1g). The slump slide moves down and out at the base along a semi-curved bearing surface which may resemble the inner surface of a spoon. Near the bottom of the slope the debris pushes up and out to form a convex surface. Earthflow produces wrinkled and hummocky topography which resembles a wet, bunched-up rug (fig. 4).

FIGURE 6. Damaged private dwellings trapped in earthflow, Macksburg, Ohio. Note open cracks due to tension.

FIGURE 7. Talus creep and slump slide, the result of strip mining of coal. Macksburg, Ohio. Note destroyed grove of trees.

Mudflow and *slumgullion flow* are quite similar to earthflow, but usually consist of a more "soupy" or colloidal mixture. They usually contain more water and clay or silt. Pools of mud and silt may gather in depressions formed by earthflow (figs. 1d, 5). Earthflow usually includes a foot or more of mantle composed of soil, pebbles and vegetation.

Solifluction and *soil-creep* are related to water and frost action. Solifluction means "soil flow" and is probably more common in regions of permafrost (ground which is permanently frozen except for a few inches at the top), as a slow downslope movement of wet semifrozen soils. In the northerly latitudes one might expect to find solifluction fairly common. Soil creep is a similar process more nearly like sliding, a slow movement of rock and soil downslope, the result of freezing and thawing action which occurs in lower latitudes.

FIGURE 8. Building balanced on edge of slump slide. Note irregular hummocky topography characteristic of slide areas, near Brecksville, Ohio.

Every Ohio farmer is familiar with the work of frost in his fields. In the spring he finds new cobbles and boulders exposed. Frost action has gradually heaved them up through the mantle and soil, and when on slopes they are subject to downhill creep. Freezing expands and lifts coarser fragments vertical to the slope-line, and thawing permits them to sag back towards the earth's center under the influence of gravity. Back-fall occurs at an angle slightly downslope in relation to the direction of original rise. Thus migration takes place in a downhill direction, carrying fence posts that must be straightened in the spring.

In order to present an exhaustive classification of mass movement, it is necessary to include phenomena which are the result of subsidence or the effects of gravity in a vertical direction. The following discussion treats with these forms of movement.

A *sink* occurs in an area of limestone where subsurface solution has developed an underground cavity in solid rock. When the roof becomes weakened and collapses a sink hole is formed. This same sink hole, however, may be the result of solution from the *surface* down and thus technically speaking is not the result

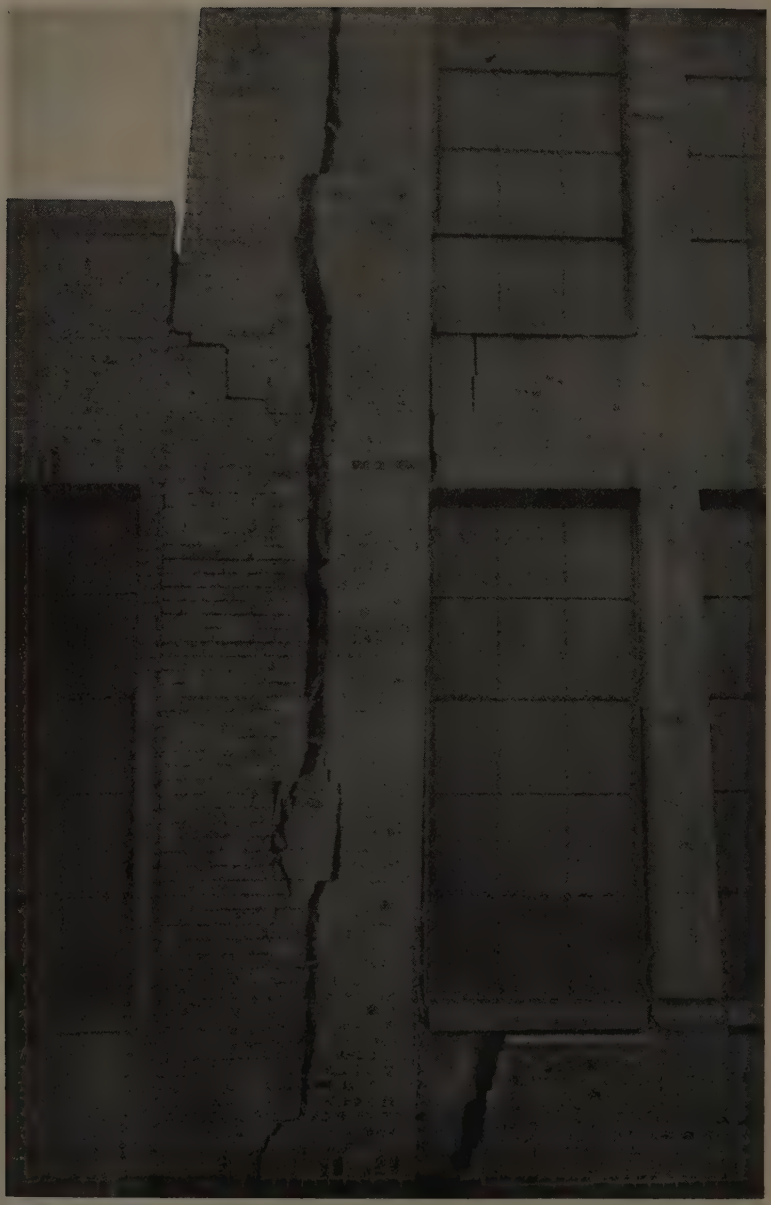

FIGURE 9. Damaged highway department building. This structure had to be torn down. Brecksville slide.

of mass-movement. *Wallows*, "buffalo- or hog-wallows" may be formed on nearly level surfaces by vertical subsidence, due to the weight of grazing or wallowing animals. *Slump depressions* occur as the result of plastic extrusion of soft or fine water-laden sediments, due to the weight of the mantle above (fig. 1f). They are subsidence phenomena as is the type called *compaction depression*. The latter may take place when closer packing of sediments occurs with consolidation due to increase of top load, or simple squeezing out of water content.

Instances of the gravity phenomena described above, too numerous to be cited, may be found in all parts of Ohio. The mechanics of earthflow associated with a specific strip mine near Macksburg, Ohio have been discussed by Savage (1950). Careless operations of mines may endanger water supplies or put mines out of business. As a result of stripping for coal near Macksburg, the natural ground water movement was disturbed and an unsafe slope was loaded with waste or

FIGURE 10. Slide is new highway fill. Concrete slab is undermined. Near mouth of Tinker's Creek, north of Macedonia, Ohio.

spoil and "many cubic yards of earth and mud moved downslope, wrecking two sets of buildings, overriding agricultural lands, destroying a wooded plot, and disrupting a through highway." Figures 4, 5, 6 and 7 are scenes at this site.

The morning papers of February 8, 1950, carried pictures and an account of an expensive slide near Brecksville, Ohio, south of Cleveland. Early in the morning after heavy rains, nearly 500 feet of highway and several Cuyahoga County highway department buildings were wrecked. A long section of the Baltimore and Ohio Railroad tracks was heaved and twisted like damp spaghetti. One private dwelling had to be towed back bodily from the brink of the slide to save it from toppling off a cliff (figs. 8, 9). Preliminary estimates placed the damage at $500,000. The author viewed the damage soon after the slide took place and in his opinion the slide occurred because of an artifical excavation at the toe of an unsafe slope on clayey silts. This is not the first time such practice has been observed, nor will it be the last. Someone once made an observation which went something like this, "Where there is a steep slope, excavate at the toe, and stand back to see the excavation grow!"

In the spring of 1951, several hundred tons of blue clayey silt in the Horseshoe Glen section of Willoughby Township moved into the Chagrin River. This slump

slide occurred when the river undercut and sapped a 100 foot bank. The slumped material formed a 10 foot dam which started to pond water to a level which might have become dangerous to nearby houses, until firemen used a hose to hydraulically wash away the debris and form an outlet.

Similar clayey silt was unwisely used to construct a ramp for a road paved with concrete, near the mouth of Tinker's Creek on the east side of the Cuyahoga Valley. The results were costly, a sizeable slide occurred and a portion of the concrete highway undermined. Extensive repairs will be necessary even before the highway has had much use (fig. 10).

In conclusion, it may be stated that the examples cited above are only a few of the many which may be found in Ohio. References at the end of this paper will be found useful to those who wish to pursue the subject further, or who may wish to read more on the subject of classification, or the engineering aspects of mass-wasting.

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Educational Psychology. *Robert S. Ellis.* D. Van Nostrand Co., Inc., New York, Toronto, London. 1951. First Edition. xi+546 pp.

Dr. Ellis has an interesting and commendably different approach to the study of psychology by those who plan to make a career of teaching.

After calling upon a goodly number of contemporaries in the field to define or clarify the functions of educational psychology, the author announces that he will use the problem approach. This he does quite consistently. As Charters has suggested, the engineer is concerned with solving practical problems. In very similar fashion the teacher also is constantly facing problem challenges which he either ignores, runs away from, or solves. He solves them only if he understands them.

So, throughout Dr. Ellis's new book, in a logically complete and comprehensive sequence the prospective teacher is familiarized with the problem areas of the profession. These include, quite naturally, the phenomena of the child himself, the curriculum, extracurricular activities, testing and marks, and efficient techniques of studying and reasoning.

In several lectures, placed strategically among the eighteen chapters, Dr. Ellis summarizes the "general principles of teaching," psychological principles applied to discipline, guidance, mental hygiene, development of attitudes, and other practical problem zones.

In this reviewer's opinion the objectives of the book are well stated and attained. The volume is readable, attractively printed and bound, and the text adequately supported by graphs, case studies, and illustrative references.

As a basic text, after a one semester introduction to general psychology, a future teacher should find this "voice out of the west" most helpful.

HOMER DUNATHAN.

A NEW MEGALURA CERCARIA FROM OHIO[1]

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A number of schemes have been devised in an attempt to classify larval trematodes, and thereby to bring some order into an area of considerable misunderstanding—frequently bordering on confusion. Lühe's (1909) work is generally considered to be the first comprehensive effort along this line. Among the groups defined by this worker, of particular interest are those organisms referred to as the Gymnocephalous cercariae. These are described as cercariae which develop in rediae, are poor swimmers, live near the bottoms of ponds, are either unresponsive to light, or show no special behavior in response to light stimulation. After encystment on herbage in the open, the cysts are passively transferred to the final host, the intervention of a second intermediate host being unnecessary. The cyst is protective to the metacercaria under fairly severe conditions of desiccation. In some instances, encystment appears to occur in snails.

Among the many modifications of Lühe's original classification, one of the better known is that of Sewell (1922). The latter has included as subgroups under the Gymnocephalous cercariae, the Pleurolophocerca, Parapleurolophocerca, Isopori, Agilis, Reflexae, and Megalura groups. It is with the last named that this paper is concerned. The Megalura group was erected in 1914 by Cort who used as the type species, *Cercaria megalura*, so-named by him, because, in his words, "of the great length to which the tail is sometimes stretched." He included besides *C. megalura*, *C. distomatosa* Sonsino and an un-named species discovered by Lutz. Sewell added a fourth member, *C. indica IV*. His studies convinced him that these larvae are related to the echinostomes, intermediate forms between the two groups being what are now recognized as the larval stages of *Parorchis acanthus* Lebour and *P. avitus* Linton.

Sewell's characterization of the Megalura group is as follows:

1. The cercariae are large, ranging in body length from 0.40 mm to 0.79 mm, and the body wall is crowded with cystogenous cells.
2. The tail is long and is composed of a very characteristic reticulate or vesicular parenchyma; a glandular adhesive organ is situated at its distal end.
3. The alimentary tract is of the "triclad" type: a short prepharynx leads back to a small pharynx, which is succeeded by an esophagus of short or moderate length. The intestinal ceca reach back to the posterior end of the body.
4. Salivary glands are probably present in all cases and consist of a group of pyriform cells, whose ducts open on the anterior lip of the mouth.
5. The excretory system consists of a small pyriform excretory vesicle from which a pair of main excretory canals arise. These contain no refractile globules. Each canal can be traced as far forward as the side of the pharynx, where it turns back and, opposite the acetabulum, divides into anterior and posterior collecting tubes. There is, as a rule, no caudal canal.
6. Development occurs in rediae which are elongate in shape. A pair of locomotor processes are present, and, in young individuals, a collar can sometimes be seen. There is a well-developed pharynx, followed by a stomach which reaches back for at least one-half of the body length. A birth pore is situated just behind the level of the pharynx.

[1]This cercaria, among others, was first reported in a thesis presented in partial fulfillment of requirements for the master's degree, at The Ohio State University, in the autumn of 1949.

7. The cercariae encyst in the open in flask-shaped cysts.

To the foregoing should be added the further observation that all known members of the group are from freshwater snail hosts.

A cercariae which, in all of its essential features, conforms with the Megalura group characteristics will now be described.

Cercaria darbiensis n. sp.

Figure 1

The cercariae were taken from snails, *Goniobasis livescens* Say, collected from Big Darby Creek, in the vicinity of Darbydale, Ohio. Examination of many hundreds of these snails reveals an incidence of infection of two percent. The cercariae escape from large sac-like redia (fig. 2) which, in many cases, have all but completely eroded the host's digestive gland (liver). The bodies of the larvae are of oval shape and, due to the abundance of mucoid material in their cystogenous cells, white in appearance.

The cercariae, after emergence in the early morning hours, are very active. They swim through the water, body foremost, their long tails lashing vigorously. By mid-morning, their activity is considerably reduced; and by noon, or shortly thereafter, swimming movements have ceased. The cercariae can then be seen covered by flask shaped cysts at the bottom of the container (fig. 3). Encystment may otherwise be hastened by agitating the vessel containing the cercariae; or by the act of transferring the larvae by means of a micro-pipette from the container to a slide. In either case, the organism may be enveloped completely in two or three minutes. In all cases, the tail is cast free, and slowly disintegrates (fig. 4).

Details of the internal structure can be studied to best advantage after, rather than before, encystment. Particularly is this true in making out details of the excretory system and its flame-cell pattern, which are greatly masked prior to the elaboration of the cystogenous substances. Then too, after about twenty-four hours, the intestinal ceca are much reduced in diameter.

The average measurements of 20 live cercariae are: body 0.736 mm long, 0.132 mm wide; tail 1.976 mm long, 0.034 mm wide; oral sucker 0.05 mm in diameter; pharynx 0.029 mm long, 0.017 mm wide; ventral sucker 0.066 mm in diameter; flame cells, 11 on each side of the body, none in the tail.

Externally, a smooth cuticle is superimposed upon a cellular epidermis. Just beneath this lies a dark, narrow band of muscle. From the oral sucker extends a short, narrow prepharynx, which enters a muscular pharynx. This is followed by the esophagus, at first constricted, then expanding as it bifurcates distally, giving rise to the two branches of the intestinal ceca. These reach nearly to the end of the body and, being greatly distended, are the most conspicuous structures in fresh material.

The excretory vesicle, when expanded, is oval in shape. It appears to fill and empty in a manner similar to a protozoan contractile vacuole. Arising from its anterior margin is a common duct, from which two excretory canals extend to opposite sides of the body, and forward to the level of the oral sucker. Along their lengths, excretory tubules branch off. To these are connected the flame cells, through which the body fluids are propelled and channelled into the excretory canals. The excretory vesicle appears not to have any communication with the tail.

The tail exhibits externally a cellular epidermis overlying a muscle layer. It is largely filled by round bodies containing what appears to be a lipoid substance. It is capable of considerable extension and contraction. The distal end is truncated and is of the nature of an adhesive disc. As the cercariae become less active, they tend to attach to the bottom by means of their tail discs. From this position they may sway with a pendulatory or revolving motion.

The cercariae to which this form seems closely allied are *C. megalura* and *C. indica IV*. Features shared by the three of them are: development in rediae, ventral sucker larger than the oral sucker, ready encystment on a solid substratum, tail truncated distally and greatly extensible. The cercaria described here differs from both *C. megalura* and *C. indica IV* in that the main excretory canals arise from a common duct, while in the latter they arise separately from the lateral margins of the excretory vesicle. A further difference is to be noted between the new cercaria and *C. megalura*. Of the latter, Cort states: "The cercaria was unable to use its tail for swimming in

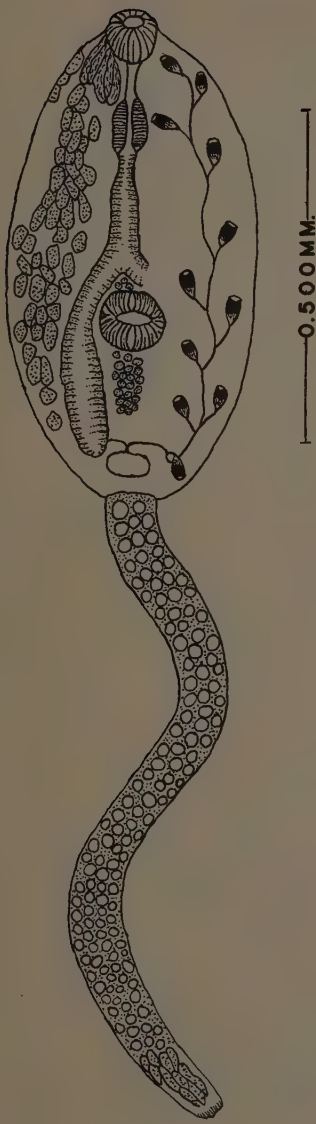

FIG.1

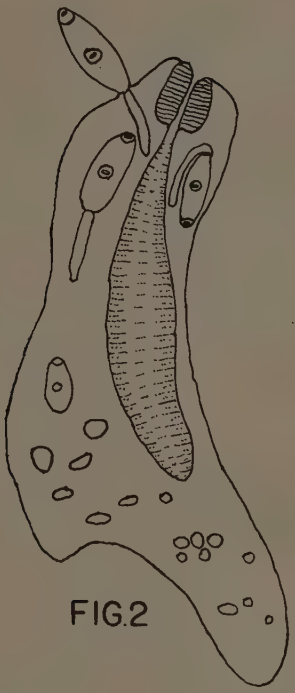

FIG.2

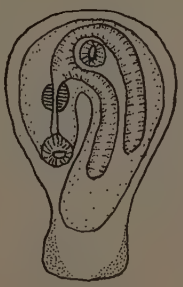

FIG.3

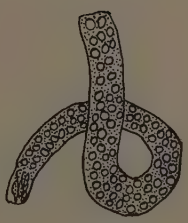

FIG.4

FIGURE 1. *Cercaria darbiensis* n. sp.
FIGURE 2. Redia.
FIGURE 3. Encysted metacercaria.
FIGURE 4. Cast-off tail.

open waters, but, on a substratum, it moved fairly rapidly with the aid of the suckers. With the acetabulum attached, the anterior end would reach out and the oral sucker take hold. The acetabulum would then lossen its grip, and the body contract until the suckers were close together . . . Locomotion consisted in a continued repetition of these movements." According to Cort, this inability to use the tail in swimming movements was shared by *C. distomatosa*. Neither the cercaria discussed here nor *C. indica IV* was so limited in mobility. There appears here a striking difference in the muscular development of the tail that may be of some genetic significance. The body of *C. indica IV* is heavily spined, and its excretory system is characterized by having 14 flame cells on each side of the body. By way of contrast, this cercaria has no spines on its body and has 11 flame cells on each side. The number of flame cells possessed by *C. megalura* was apparently not determined.

The morphological features of the cercaria described in this paper seem to justify its inclusion in the Megalura group. Moreover, its variation from forms previously described appear to justify one's considering it to be a new species.

ACKNOWLEDGMENT

The writer makes grateful acknowledgment of the frequent suggestions and constant support of his adviser, Dr. J. N. Miller.

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FACT AND MYTH IN SOCIAL CLASS THEORY

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Among the problems confronting sociologists, none is more perplexing than the discrepancy between generalizations about class trends on the one hand and the evidence of common sense on the other. Recent studies in stratification have described American society as tending toward decreasing mobility, crystallizing statuses, and hardening class lines (Lynd, 1937; Warner and others, 1941, 1947). Yet there persists, in both lay and scientific groups, much skepticism regarding these conclusions. Some of the skepticism may represent an unconscious defense of the myths of a competitive society; but an important part appears to be more objectively grounded. In common experience there are repeated suggestions that the portrait of the United States as a slowly-congealing social system may be essentially false.

SOURCES OF ERROR IN CLASS THEORY

The ambiguity in contemporary thought about social class is especially significant for two sectors of class theory. The first is the area of conceptual analysis, where present activity centers on the identification and description of class. This area is implicated because of certain weaknesses in the over-all theory of class systems. In particular, the linkages between class structure and the major dynamic influences in society—e.g., technological change, or shifting power structures—remain poorly conceptualized. As a result, trends in stratification tend to be generalized from perceptions of short-term changes in the empirics of class, not deduced from a realistic system of class theory. Insofar as taxonomy and primary structural analysis are a necessary first step in science, a full-blown theoretical system is hardly to be expected at this stage in the history of sociology. Until a more productive conceptual scheme is achieved, however, the present confusion about social class is likely to continue.

The second sector of theory implicated in this problem is concerned with the dynamics of class. This sector contains generalizations about changes in vertical mobility, criteria of status, intensity of class consciousness, and rigidity of stratification. A primary difficulty in this area is that motivation has run well ahead of technique—the result, in part, of a concern with practical problems in a period of crisis, and, in part, of stimulation by radical theories of social process. The latter include hypotheses about the proletarianization of the masses, the inevitability of class conflict, and so on. The content of this area is somewhat polemical, despite the moderating influence of such work as Cooley's (1925) analysis of the evolution of class systems, and Sorokin's (1927) investigation of social mobility. In general, it is this sector of class theory whose hypotheses merit the lowest level of confidence, and it is here that a concern with myth is probably most appropriate.

This discussion will consider three types of data on changing class structures: (1) empirical generalizations, (2) isolated analytical hypotheses, and (3) systematic theories. All degrees of generality, speculativeness, and consistency will be found in these materials. Their principal common feature is a support, implicit or otherwise, of the conclusion that American society is tending toward increasing rigidity of class lines.

REPRESENTATIVE ELEMENTS IN CONTEMPORARY THEORY

The major generalizations in class dynamics deal with the monopolization of certain social values by select groups. Representative among these are the

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following: Sorokin's (1927) finding that millionaires tend increasingly to be the offspring of millionaires; the Taussig and Joslyn (1932) discovery that American business leaders are increasingly the sons of business leaders; the Lynd (1937) and Warner (1947) observations that entrance into the ranks of management from the shop or assembly line has diminished markedly in recent decades.

In some studies of stratification trends, the generalizations embrace not just one occupation but families of occupations, or even whole social strata. The Lynd (1937) report on the second Middletown study, for example, implies increasing exclusiveness in the independent professions relative to the salaried or dependent professions. Somewhat analogous is Mills' (1946) discovery of a tendency toward increasing rigidity in the upper middle class, not only occupationally but also in other respects.

These direct indicators of a crystallizing class structure have been partially integrated by a number of analytical hypotheses. Several hypotheses relate to the declining effectiveness of institutions as aids to upward social mobility. The industrial organization, the credit structure, and the educational system have all been singled out as elements of society whose mobility function has been impaired (Lynd, 1937; Mills, 1946; Warner, 1947). Other of these hypotheses connect shrinking mobility with an increasing interest in compensatory goals, ranging from labor union activity on the one hand (Havighurst, 1947), to escape through vicarious experiences in the media of mass communication on the other (Smith, 1950).

The larger conceptual schemes dealing with class evolution give general support to the foregoing generalizations and hypotheses. Cooley (1925), by tying the emergence of class lines to competition and lineal inheritance, provided a rationale for future increases in the incidence of occupational and status inheritance. Other social scientists, notably Linton (1936), posit a close relationship between the working out of smooth adjustment in a society and an increase in the ascription of status. On the basis of this scheme one would anticipate signs of growing rigidity or hardening statuses in a society that was approaching "maturity." Finally, exponents of functional theories of stratification (Davis and Moore, 1945) have held that increase in rigidity should follow the definition and initial allocation of functions in a social system. This is in some respects a special case of Linton's theory, and entails much the same consequences for a society such as this.

These conceptual schemes all represent increasing stratification as a natural tendency in human societies. There is something analogous to negative entropy here, operating to place societies in a state of elaborate organization and unequal distribution of status. These outcomes, it should be noted, have basis both in logical implication and in empirical evidence. Historical materials as well as logic seem to suggest a general theory of class development in which progressive elaboration and status differentiation are fundamental consequences of the theory. Anthropological materials, for example, reveal a trend toward greater involvement in class systems in the more populous and more complex societies (McConnell, 1942). Other data show tendencies toward greater rigidity with increasing age and perfection of function in institutions (Cooley, 1922). There seems, therefore, ample justification for the existence of theoretical schemes of this character in the field of social stratification.

In the evaluation of the preceding materials, a number of approaches are possible. One might take exception to specific descriptive generalizations or hypotheses without questioning the underlying conceptual scheme itself. The frequency of methodological error or valuational bias makes this procedure desirable as a routine measure. It is also possible to raise questions as to the appropriateness or sufficiency of the conceptual scheme. At the present time both these courses appear necessary.

RECENT EMPIRICAL FINDINGS

In an attempt to throw light on stratification trends in the United States, the writer has been studying occupational origins (defined as the "principal occupation of the informant's father") of business and professional men. Since 1947 two-generation histories have been obtained from about 1400 randomly-selected informants in several middle-sized cities. These data permit analysis of two kinds of trends. One is the secular trend of occupational origins of the informants, which provides a continuous index of gross rates of mobility in the society. The other is the trend of regional or geographical differences in origin means. The latter data provide a comparative picture of rigidities of older and newer sectors of the society.

The results of this study thus far may be summarized as follows: (1) Among "big businessmen," employers of 100 or more persons, occupational origins appear to be rising; also, there are no statistically significant differences between regions in origin means for this group. (2) Among professional men in the fields of medicine, law, engineering, and secondary-school teaching, the secular trend is one of gradually decreasing occupational origins. (3) For independent professionals, the most rapidly declining origins are found in medicine, which possesses the highest status of any profession in this society. (4) The mean occupational origins of professionals are lowest in the older parts of the nation, which contain, inferentially, the older sectors of the society. (5) In all the professions, but especially in law, there was a noticeable rise in occupational origins among the groups which entered these occupations in the 1930's.

These findings suggest a number of conclusions that are important for the preceding discussion. First, there is a continuing trend toward decreased occupational inheritance in the professions in this society. Second, there is no clear evidence that the educational system is becoming less effective as a channel of upward mobility. The reverse appears to be more probable. Third, the older, or what are believed to be the more status-ridden parts of the society, seem characterized by the greatest freedom of mobility into the professions.

Several criticisms of current stratification theory in the United States are implicit here. Many of the hypotheses concerning the role of education in the class system are undoubtedly questionable. Likewise, some of the generalizations on vertical mobility in certain occupations and strata appear to be contradicted. Finally, the total system of hypotheses relating to the rigidity of the structure of American society is in need of re-examination.

These criticisms become more pertinent when other factors are brought into consideration. If Mills' statement on increasing rigidity of the upper middle class is examined, the published evidence seems to be one empirical datum. Mills (1946, p. 528) states, ". . . the top (of the class system is) becoming more rigid: 73 per cent of the upper half of the income-occupational scale are descended from the upper half." Since no information on descent of younger as compared with older informants is given, the conclusion is a subjective estimate, open to all the hazards of such estimates. Similar criticism may be made of the Lynd (1937, p. 70) appraisal of inheritance trends in the independent professions in Middletown. Because these professions were relatively constant in membership for a generation or more, it was inferred that the former were not being entered from lower strata at significantly increased rates.

Two circumstances appear to make much of the empirical generalization and substantive theory on class phenomena somewhat suspect. One is the fact that the relevant research was done in a time of social crisis, and by men whose value systems inclined them toward progressive social action. The Lynd and Warner studies, empirical backbone of the "increasing rigidity" school, were both products of depression years. As such, they carried facts and inferences about a "maturing

economy," increasing conflict between business and working classes, and the like. But more than that, they revealed some readiness to indict the existing social order for both real and fancied shortcomings. The extent to which personal value systems determine the character of professional judgments of social scientists has been well elaborated elsewhere (Mills, 1943). The fact that such determination occurred in the recent history of class theory appears an almost incontestable proposition.

Aside from the impress of social values on their science, the depression years were unique for class theorists in another way. In the realm of empirical materials, these years yielded data whose projection into the future would have resulted in vast errors. The marked rise in occupational origins of attorneys during the 1930's is instructive here. Insofar as materials on stratification are loaded with data taken in this highly atypical period, a balanced perspective on trends has been difficult to achieve.

NECESSARY CONCEPTS IN DYNAMIC THEORY

Although ideological bias and contradictory evidence may be adequate grounds for questioning empirical findings on class, the most cogent criticisms of over-all conceptual schemes seem to be of another character. One point of departure is the inappropriateness of existing theory for analysis of societies such as this. Because of the nature of the social systems from which they derive, working hypotheses like those of Cooley, Linton, and Davis are more applicable to traditionalistic than to rationalistic structures. In societies of the latter type, increasingly dominated by scientific method, secularization, rationalization, and individuation, these theories need modification, or perhaps rejection.

The crucial test of the appropriateness of these conceptual schemes is their utility in predicting trends in class systems. However, lack of refinement in the schemes renders definitive testing of their predictive value impractical, so that the question of appropriateness must remain essentially speculative. It is possible, on the other hand, to raise the question of logical adequacy in a meaningful sense. Existing conceptual schemes fail to give place to, or at least to make explicit, certain variables that are increasingly significant for class systems, particularly in societies of the rationalistic type.

One of these variables is *power*, conceived simply as ability to influence behavior of individuals toward desired ends. Many changes in class systems in the Western world appear to be related causally to changes in what political sociologists call the "structure of power." This structure is determinately related to the criteria of status and the system of classes in human societies. An appreciable modification of power relationships is often followed by a redefinition of the criteria of status, and a consequent reshuffling of persons, positions, and roles. In brief, the rise of a new basis of power in a social system tends to recast the class structure of the society in greater or lesser measure.

In recent history, reorganization of power structures has tended to occur with increasing frequency, often as the unanticipated result of some phase of rationalization. Each major technological or social development forces a readjustment; and each readjustment, to paraphrase MacIver (1947, p. 105), has tended to benefit the group just below the incumbent power-holders. At the present time, interest centers on the strata commonly designated the "lower classes." By exploiting the power resident in organization, these classes are in a position to force further adjustments in present-day class systems.

Recent British experience is illuminating on this point. What appears to be indicated is not only a growing amenability of class systems to social pressure, but also an increasing intention to apply such pressure. Oxford historian Woodward (1950, p. 37) cites British labor leaders as remarking, in effect, "We intend to break the upper middle class, just as we broke the landed aristocracy." What-

ever the historical accuracy of these claims, the underlying sentiments are symptomatic of pressures in social structures that cannot be ignored by class theorists.

Related to the growing power of the lower classes, and partly determined by it, is the *redistribution of income* in Western society. A conspicuous feature of the secular rise in standards of living is the disproportionate improvement in the economic position of the lower classes. A short-term view of this process in Britain has been reported by Weaver (1950). Great Britain's working classes now take about 22 percent more consumer goods and services than before the war. Middle class consumption is of the order of 16 percent below that of prewar, and the wealthy classes now consume about 42 percent less than they did in 1938.

Although comparable figures are not available for the equivalent classes in the United States, there has been a parallel development here. Hayes (1947) has titled it, "The narrowing gulf between rich and poor." Income differentials are being progressively reduced, partly by devices characteristic of the "welfare state," and partly by a continuing rise in real wage levels in lower income brackets. Since 1900 there has been an increase of 108 percent in the purchasing power of the average factory worker (Bureau of Labor Statistics, 1950). By way of comparison, college and university teachers, who may reflect roughly the changing fortunes of the middle classes, have approximately the same standard of living in 1950 as in 1900.

The significance of the redistribution of income among classes and the relative gain of the lower classes is two-fold. (1) Lower-class children have freer access to channels of upward mobility, with a consequent improvement of their chances in status competition with children from higher strata. This growing advantage may be evident in the declining status origins of professional persons in this society. (2) There is also a blurring of distinctions between status groups. A decrease in income differentials favors homogeneity of dress, cultural values, and style of life in general. The meaning of these for mobility differentials is clear. Like the downward diffusion of power, the leveling of incomes is a factor for reduced rigidity in society, and should have some place in a functional analysis of class.

Somewhat similar is the leveling in *occupational prestige* in contemporary industrial societies. This trend is a function of increasing need for skill in performance of the roles of a technologically and administratively complex social order. The extent of the trend may be indicated in several ways. One procedure is to assign occupational groups in the decennial census a prestige rating from one of several occupational rating scales. This permits comparison of prestige means of the working force in different census periods. In terms of points on the North-Hatt (1949) occupational rating scale, the average occupational prestige of the gainfully employed in the United States rose from 59.5 to 63.0 in the period between 1910 and 1950.

A notable aspect of the shift in occupational prestige is the fact that much of it is occurring through a reduction in percentages of unskilled workers. Schematically, this may be described as a shift of the lower-lower and upper-lower classes in the direction of the middle. This process has been noted in relatively advanced stages in some countries with longer histories of industrialization. Woodward (1950, p. 54) reported a virtual disappearance of the lower classes into the middle classes in Sweden, and the beginnings of a similar development in Britain.

There is a fourth variable that needs consideration in a functional theory of class in modern society. This is the phenomenon of *rationalization*, which now has touched practically all sectors of Western culture. In general, this process subjects both ends and means of social life to objective examination and rational determination. One major consequence is a pressure toward reduction of the amount of traditional behavior present in a society. Since much of contemporary

class theory implies a gradual rise in traditionalistic behavior, adherence to present conceptual schemes necessitates either a disregard or a minimization of the process of rationalization.

An important potentiality of a rationalized society and a democratic structure of power, in the present context, is that social class may take on the attributes of a "social problem." Specifically, class distinctions of the kind now evident in this society may become generally regarded as undesirable, and hence the proper object of modification through the usual channels of social action.

Indications of strain in this direction are fairly common. In the United States the trend is most evident in the area of educational opportunity. The principal actions thus far are federal aid to veterans of World War II, the growing system of community and junior colleges, and, in the nature of a token, the New York state scholarships for talented high-school graduates. On the level of plan and sentiment, there are bills before the 82nd Congress—S3996 and HR9429—which propose aid to college students on the basis of "demonstrated ability," and some disposition on the part of the Congress to resist draft deferment for college students without compensatory action in behalf of non-college youth. Outside the field of education, various aspects of the welfare state may have found their motivation in much the same kind of sentiment.

CONCLUSIONS

The patterns of power, income, prestige, and rationality in behavior are not the only elements necessary in a dynamic theory of stratification. Consequently, detailed consideration of shifts in these patterns will not provide a complete explanation of trends in the rigidity of class systems. To neglect their consideration, however, is to run the risk of arriving at an erroneous perception of structural and functional changes in class phenomena.

How far attention to the foregoing variables will reduce the myth content of class theory is impossible to estimate. In practice, the reduction will necessarily be a joint operation; adequate theoretical analysis must be coordinated with methodologically sound empirical investigation. Weakness in each of these departments has contributed to the present contradictions in class analysis, and the improvement of each appears essential to any substantial progress in the field.

Two important values should arise from the theoretical changes indicated in the preceding discussion. Differences between class structures in industrial democracies and those in other socio-cultural systems should be made more comprehensible. In addition, a more sensitive approach to the prediction of stratification trends in Western class structures should be facilitated. In the latter regard, particularly, the needs of class theory are acute. The influences which have had the heaviest impact on status relations in recent decades seem to be elements that contemporary theory is little prepared to manage. The result is an ambiguity as to whether the weight of these influences is primarily on the side of a reduction of present-day class differences, or on the side of a crystallizing status system. This ambiguity is not likely to be resolved without some attention to the task of theoretical reconstruction.

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Deciduous Forests of Eastern North America. *E. Lucy Braun* The Blakiston Co., Philadelphia. 1950. xiv+596 pp. $10.00.

This publication, an outstanding contribution to plant geography, is certain to be a widely cited reference in plant ecology and related fields for many years. In the first place, no other book of its kind is available and, secondly, the material on which it is based (the primeval vegetation of Eastern United States) is rapidly becoming decimated.

The author's concept of the deciduous forests of eastern North America embraces the whole forested area south of the Boreal Forest, sometimes sub-divided into the Hemlock-Hardwood, Southeastern Evergreen, and Deciduous Forest formations. The three major objectives expressed in the text are as follows: to describe the primeval forests; to give data on floristic composition and aspects; and to trace the pattern of forest vegetation through its geological history. When one contemplates the vastness of the problem area and the great age of some of the communities, it may be said that the writer has been eminently successful, even though the sample quadrat analyses seem somewhat inadequate.

Treatment of the forests is descriptive and from the physiographic point of view, the boundaries of the forest regions coincide almost perfectly with Fenneman's physical divisions of Eastern North America. The descriptions are augmented by 97 excellent illustrations and 91 tables; in addition there is a large map of the forest regions inserted in the back. Factors other than historical are not discussed. The part given to vegetational history is presented in a dynamic fashion. There may be some who disagree with the Braun viewpoints, but no one has ever before put the story together. No matter what phase of research the forest ecologist may approach, the book will form a broad beginning base from which to start.

The work is based on 25 years of personal field work, and the author has drawn freely from literature, citing more than 600 titles. The publication will be a useful reference to others than plant ecologists, especially to foresters, conservationists, geographers, and animal ecologists. For those unfamiliar with botanical nomenclature, an index of scientific and common names has been included; and there is also a subject index.

J. N. Wolfe

RIDDELL'S NOTICE OF VEGETABLE PRODUCTIONS GROWING SPONTANEOUSLY IN WASHINGTON COUNTY, OHIO[1]

RUSSELL LEE WALP

Department of Biology, Marietta College, Marietta, Ohio

Although Ohio has been explored and claimed by the Spanish, the French, and the British, with civilization having made inroads prior to the Revolutionary War, we have no record of any collection of plants by a trained botanist prior to 1832. During the summer of 1832, we have a record of the first collection to be made in Ohio by a professional botanist. This, strangely enough, is recorded in five issues of the *Western Republican and Marietta Advertiser*[2] for September 1, 8, 15, 22, and 29. The collection was made and the list prepared for the newspaper by John Leonard Riddell. It is interesting to note that the *Western Republican* was published and edited by John Brough who later became the Civil War Governor of Ohio, and that Riddell, for the same period, was Postmaster of New Orleans.

John Riddell had no formal schooling with the exception of this training with Amos Eaton, Senior Professor of the Rensselaer Institute. Eaton had written the *North American Botany*, which, at the time Riddell studied with him, had gone through its 5th Edition, for Eaton was the foremost Botany teacher of his day. Riddell, having received his Bachelor's Degree, decided to do some free lance teaching by giving lectures to any group which would pay him. His primary interest, however, was to teach in a Medical College, and this was probably his reason for going to Marietta. While he was in Pittsburgh, he heard of Dr. Hildreth's influence and interest in botany through the latter's brother-in-law. Riddell made a wise choice by going to Marietta as Hildreth had a wide acquaintance and influence thoughout the State. Dr. Hildreth was instrumental in placing him at the Worthington Medical School and later at the Cincinnati Medical School. While he was at Cincinnati, Hildreth hired Riddell to help him on the State Geological Survey. To show his gratitude, Riddell invited Hildreth to come to Cincinnati to receive an honorary degree in medicine, which he, himself, was having a difficult time in acquiring. Because of floods, Hildreth was unable to accept this honor.

After a slight scandal in Wheeling, Riddell arrived in Marietta about the time when most of the spring flora had gone to seed or had died down. For nearly sixty years, the rich river bottoms had been under cultivation by the white man. An old diary mentions that a peach orchard was well established during the Revolutionary War. General Harmar, who was sent to the mouth of the Muskingum in 1785 to build a fort to protect the Indians from the white man's exploitations, writes that this vicinity had a population of three hundred and that all of the bottom lands were under cultivation. Squatters who came here had cleared two hundred acres north of what later became Marietta, and the early settlers who claimed this land were the only ones who had successful crops during the first year of their stay in Marietta. Thus, by 1832, Riddell very likely saw little virgin land, and there had been plenty of opportunity for introduced plants to become well established.

At Dr. Hildreth's suggestion, Riddell placed an advertisement in the *American Friends* to publicize the fact that he would collect plants for sale. Since Marietta

[1]Paper given in part before the Botany Section of the Ohio Academy of Science, Capital University, Columbus, Ohio, April 28, 1950.

[2]The author wishes to thank Mrs. Josephine Phillips for drawing his attention to the Riddell articles and the gift of the *Western Republican*, September 1, 1832.

did not offer an opportunity for a paid lecturer or trained botanist, he had to do something else in order to pay for his room and board of $1.50 a week. He must have been more successful with the rival newspaper because he not only got his advertisement gratis for writing a description of the flora of Marietta, but in addition, the editor pointed out to the reader that the plants which Riddell was trying to sell were all excellently pressed. The following is the notation made by Mr. John Brough:

We call attention to the communication of Mr. Riddell, in this day's paper. We have seen several specimens of plants preserved by Mr. R. and must confess they exceeded in beauty and 'perfection of finish,' our utmost expectations.

Below is the article written by Riddell in the *Western Republican* for July 14, 1832. Note that the last paragraph is the same as that for which he had to pay in the rival newspaper.

Spontaneous Vegetable Productions of Washington County

It is said that very little has been done in this section of the country, to investigate the spontaneous vegetable productions. Here then, is an interesting region to examine. These fertile valleys, from time immemorial, may have been the unobserved residence of rare and valuable plants. Perhaps the hills yield some spontaneous vegetable, which when it shall have been improved by cultivation, will find its welcome way to our tables. I have proposed to engage in a few months in making botanical examinations; collecting and preserving at the same time, specimens of all the plants I shall meet with, not for myself only, but for others who may wish to possess them. I am the more anxious, from having made botanical collections in different parts of New York and Canada. As far as practicable, I intend to note the localities of different plants, the abundance or scarcity of timber trees and valuable herbs, the geological features of the country, and the various minerals that may present themselves, whether they are to be considered as sources of wealth, or mere matters of curiosity. The richness or sterility, the composition and variety of soil, being more intimately connected with the main subject of investigation, will receive proportionably more attention. Among the higher order of vegetables, such as shrubs and trees and flowering herbs, I am far from entertaining sanguiun hopes that this enterprise will lead to the discovery of anything new. But the variegated lichens that hang from the branches of trees, the lowly mosses that fix their habitation on the barren rocks, and the pale fungi that abound in damp and shady places, have been less eagerly sought for. Every marsh and every ancient forest, have some of these strange vegetables almost peculiar to themselves; and it would indeed be unusual, if among the cryptogamous plants indigenous to this part of Ohio, there should be none except such as have been discovered and described in other regions.

That this investigation respecting the native growth of field and forest, if faithfully conducted and successfully completed, will be serviceable to the cause of science, must at least be obvious to her votaries. It will not only serve to determine the vegetable productions near Marietta, but like an almanac, will answer tolerably well for contiguous parts of the state. I trust it will also be obvious to an enlightened community, already noted for their successful efforts to promote the diffusion of useful knowledge, that such a measure, though novel in itself, is eminently calculated to improve and exalt the taste, and particularly to direct the attention of the younger members of community, from objects which are trifling and unimportant, to those which deserve their highest admiration.

My object in making dried collections for a number of Ladies and Gentlemen, is in the first place to defray expenses. Besides, I feel confident they will regard them as a useful acquisition to a library, an invaluable reference to the *wild flowers* that meet them in their walks, and a laudable source of amusement and gratification, whether nature reveals in her verdant forests and flowery lawns in summer, or leafless vegetation lies benumbed or lifeless beneath the chilling snow of winter. If painted representations are highly prized, from the faithfulness with which they record the general outline, the finer structure and the delicate coloring of plants and flowers; how much more valuable is the plant itself embalmed, still retaining (as in

most cases it does), its nicest form and fine refreshing hues; while for perfection or finish and delicacy of organic structure, it is infinitely above the most admired and successful effort of human art.

No books are more expensive than those containing plates of natural history. In America, very few large works of the kind has been published. According as they have sold in Europe, a work containing colored representation; of two hundred plants would cost more than $100. Dr. Bigelow some years since published plates of sixty medical plants, the price of which was $22.00. In the proposed collections the specimens will be neatly arranged in sheets of writing paper, and accompanied with their names, qualities, etc. at the following prices—$4.50 for 100 species—$6.50 for 150 species—$8.75 for 200—$10.75 for 250 species. Those wishing to have the plants put up in paper of a superior degree of fineness will incur an additional expense. Gentlemen living at a distance and wishing to become subscribers, will please enclose the money by mail.

J. J. Riddell, A. B. R. S.

Marietta, July 6, 1832.

The A. B. R. S. is interesting as it indicates that Riddell had his Bachelor's Degree from the Rensselaer School. He knew that he would need more than that to be able to get a position in one of Ohio's Medical Colleges, so he wrote to Eaton, and by September 1, he was able to write A. M. R. S. after his name when he published the results of his summer's work. We do not know how many subscribers Riddell obtained for his plants, but letters to Hildreth indicate that there probably were at least three—Dr. Hildreth, Dr. Cotton, local physicians, and a Mr. French, a teacher who later taught at Marietta College.

Riddell collected the rest of the summer, but in the meantime, he was writing to various Naturalists and Presidents of Medical Schools trying to find a position. In his journal for August 26, 1832, he writes:

> I have received an answer from Morrow of the O.R.M.C., and from what he says I might lecture there . . . I have commenced writing my botanical report and it pleases me very much.

The report he speaks of is undoubtedly the list of plants which Blough published in the *Western Republican and Marietta Advertiser*. Four of these are reported here. The last issue was to appear in September 29th edition, but this has never been found by the author. These four articles contained descriptions of some 190 plants. The first two issues contained about 50 and the last two issues about 140. In the September 1 and 8 copies of the paper, he writes rather leisurely and describes his plants, giving their habitat and medicinal uses, and in one instance wonders about how the spital insect makes its froth. If the plant is not described in Eaton, he suggests it may be new, and in one instance, he gives an undetermined plant a local name, *Eupatorium muskingii* (see letter to Hildreth). Some of the plants he collected around Marietta may have been new varieties or species as we know that he, himself, in his *Western Synopsis of the Western Plants* describes several new species and that several plants were named for him. But beginning with the September 15 issue, he only mentions the plant by name, unless he finds it undescribed in Eaton, and even here his notes are too brief to know what this newly undescribed plant might be. The reason for his merely listing the plants is that he has been given the position as lecturer in chemistry at the Worthington Medical School.

A note in the *American Friend* for September 8, tells us that he stayed in Marietta until about the middle of September, and that he lectured to the Lyceum on electricity and not botany. His botanical report is printed below just as it appears in the newspapers. One will be interested to note the lack of errors made by the typesetter, so few in fact, that the author felt that it was unnecessary to correct them. To make the list of plants more useful to those unfamilar with the nomenclature of Eaton, footnotes have been added. The botanical names used in the footnotes are those accepted by M. L. Fernald in his Eighth Edition of *Gray's Manual of Botany*.

NOTICE OF THE VEGETABLE PRODUCTIONS

Growing spontaneously in Washington County, Ohio

To the Officers and Members of the Marietta Lyceum.

GENTLEMEN:—Though the notice which I have the honor of submitting to you, is considerably imperfect, yet I hope it will be found subservient to the objects for which you are associated. With feelings of personal obligation for the assistance you have rendered, in these pleasing and useful researches, I remain your obedient servant.

JOHN L. RIDDELL, A. M. R. S.

NOTE—The plants are arranged under the natural orders of Jussiere.

Aroideae

The natural order including the water arum, Indian turnip, etc. The Indian turnip, (*arum triphyllum*)[3] is met with in the more elevated woods, though it is not very abundant. It has a smooth stem, frequently variegated with purple and green, dividing itself into two branches, each of which bears three large smooth leaves. The oddly shaped flower is so strangely mottled with purple and white, or purple and green, that it is easily recognized by all who ever saw it. The medicinal virtues of its turnip-shaped root, reside mostly in a spicy and acrid principle of a very evanescent nature.

The skunk-cabbage, (*ictodes foetidus*)[4] is said to grow upon the bottom lands along the Muskingum and Ohio rivers, but I have not seen it.

Asparagi

Tribes of asparagus, green brier, etc. In the shaded recesses and rocky ravines of Mile Run, west of Point Harmar, I have observed the giant solomon seal, (*convallaria multiflora*),[5] rearing its arched stem, and exposing its alternate, dark green leaves, in a condition usually thrifty and fine. A species of solomon seal, (*convallaria racemosa*),[6] grows more abundantly in the same localities, which in some respects is quite remarkable. Its berries, borne in a loose cluster at the summit of the stem, are perfectly round, and possess the lustre of polished chalcedony. They are so variegated with differently shaped spots of reddish brown, upon a ground of light green, as to resemble the parti-colored eggs of birds. I have seen many of the same species on the St. Lawrence river, but this beautiful peculiarity I had never observed.

The green brier (*smilax rotundifolia*) is a beautiful climbing plant, bearing bunches of smooth round berries, in such a fashion as to make a perfect sphere; in the centre of which all the foot stalks from each particular berry, are united. I imagine those who are fond of ornamental shrubs and vines, have but to observe the graceful foliage and fine color of this species of green brier, to believe it deserving their attention. The only place where I have seen it growing, is in the ravine north of the great mound. Other species of smilax seem more generally diffused, and some quite abundant. The *S. quadrangularis*,[7] with its four sided stem and unfriendly prickles, may be frequently met with in most all situations. The *S. cincidifolia*,[8] which grows in the ravine referred to above, resembles it. West from Point Harmar, upon a hill which deserves to be noticed for the ferns it produces Dr. Hildreth and myself observed the *smilax walteri*,[9] each one of whose dark glossy leaves is transversed by three nerves.

Alismaceae

Waterplantain, and arrow leaf tribes. In most damp places, and along the banks of small running brooks, may be seen that singular plant, the arrow head, (*sagittaria sagittifolia*),[10] the

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[3] *Arisaema triphyllum* (L.) Shott.

[4] *Symplocarpus foetidus* (L.) Nutt.

[5] *Polygonatum biflorum* (Walt.) Ell.

[6] *Smilacina racemosa* (L.) Desf.

[7] *Smilax rotundifolia* (L.) Eaton's names and descriptions of this genus are very confusing; this accounts for Riddell's difficulties with the group.

[8] *Smilax cercidifolia.* This is a misprint. Riddell, however, likely had a variety of *S. Bona-nox* L. instead of Pursh's *S. cercidifolia*, 1814.

[9] *Smilax Walteri*—Pursh. Not reported for Ohio.

[10] *Sagittaria latifolia.* Willd.

leaves of which, growing up ten or twelve inches from the ground, precisely resemble in outline the head of an ancient arrow.

During low water, a species of pondweed (*potamogeton fluitans*),[11] may be seen growing from the bottom of the Muskingum river, its oblong and pointed leaves carelessly floating upon the bosom of the water, agitated by every wind and wake, yet securely retained by their long foot stalks, like a fleet of anchored vessels. The influence of situation on vegetables, is here finely exemplified. Before the leaves reach the surface of the water, they are long and grasslike, membranous and almost transparent; but when floating between the strata of water and air, they become smooth and opaque, and acquire an appearance as widely different as can be well imagined.

Lilaceae

The lily and other tribes. On hilly forest ground, shaded by the oboriginal beech and maple, you will see the pale and delicate bellwort, (*uvularia puberula*),[12] and on the steep sides of ravines, scarcely ever visited by the sun's rays, you will find two or three other species of bellwort (*uvularia perfoliata, U. sessilifolia*), which in their general appearance, resemble the solomon seal.[13]

Asphodeli

The tribes of onion, asphodel, etc. In a very few places, overgrown with copsewood and bramble, I have seen that valuable medicinal plant, the yellow star root, (*aletris aurea*).[14] Its finely shaped leaves, resembling in color and texture the young shoots of indian corn, proceed mostly from its bulbous root buried in the ground, while from their centre the flower bearing stem rises two or three feet in height. The root is said to be excellent for domestic cholera, bowel complaints, etc.

Orchideae

The families of orchis, ladies slipper, etc. I have observed several individuals of this strange but interesting race of vegetables, growing in the most secluded places, as if averse to the progress of cultivation and improvement. Perhaps none of our indigenous plants are more difficult to domesticate. In nearly all wild and unfrequented situations, from the shaking bogs of a marsh, to the sterile declivities of the sandy upland, species of the orchis tribe will occasionally flourish in all the eccentric luxuriance and splendour peculiar to themselves. The same species carefully reared under the skilful hand of the gardener, will dwindle away and become extinct. I have seen the giant orchis (*habenaria dilatata*),[15] in the marshy ravine, north of the great mound.

Those who visit the woody solitudes a few miles west of Point Harmar, will meet with the rattlesnake-leaf-(*goodvera pubescens*), spreading its curiously mottled foliage in the shades of the laurel and pine. This plant is said to be an excellent antidote to the bite of serpents, but it probably received its common name from the singular appearance of its leaves. They are of an oval, pointed form, and of a dark green colour; but so striped and checked into figures of all shapes, by wandering lines of white, as to resemble the skin of a serpent.

Hydrocharides

Families of the mermaid and tape grass. The tape grass—(*vallisneria spiralis*- is[16] mostly seen growing in company with the pond-weed, in the waters of the Muskingum river. It may be known by its narrow grass-like leaves of a dirty green colour. This aquatic plant has attracted much attention, on the account of the singular economy of its flowers. (*Vide Paley's Natural Theology*)

[11] *P. nodosus.* Poir.

[12] This plant described by Michx. is not supposed to grow West of the Alleghenies, likely mistaken for *Uvularia grandiflora.* Smith.

[13] In a letter to Hildreth *Dioscorea villosa* L. should be added to Riddell's list of plants.

[14] *Chamaelirium luteum* (L.) Gray. In a letter to Hildreth, he asks him to change the above to *Veratrum luteum* and goes on to say Torrey identified it for him.

[15] *H. hyperborea* (L.) R. Br. var. *huronensis* (Nutt.) Farw.

[16] *Vallisneria americana*—Michx.

Aristolochiae

The snake roots. The Virginia snake root (*aristolochia serpentaria*),[17] grows plentifully in the pawpaw thickets along the banks of the Muskingum and Ohio. This celebrated medicinal plant may be known by its climbing stem, and large heart form leaves.

In elevated woodlands, and fields more recently reclaimed from the wilderness, may be seen the remform leaves of the wild ginger, (*asarum canadense*), known also to many as the white snake-root. A tincture of this root in dilute spirit, makes a pleasant bitter, possessing very active tonic qualities.

Lauri

The family including the camphor tree, the sassafras, and spice bush. The sassafras tree, (*laurus sassafras*),[18] which is met with almost every where, is covered when young with a rich green bark, peculiarly beautiful. The bark and roots possess a pleasant flavor, and exhale an agreeable and peculiar odour, occasioned by a volatile oil, which is extracted for medical purposes. This oil, as well as rape seed oil, naptha, and sulphuric ether, is a solvent for India rubber.

The most remarkable peculiarity of the sassafras tree is the strange anomaly of its leaves. The same tree, and even the same branch bears a variety of leaves shaped entirely different. Some will be long, some will be nearly round, some will be forked, and some eared like the leaves of sorrel; while others with an admirable symmetry, will be divided into three equal lobes.

The spice bush (*laurus benzoin*),[19] becomes here a shrub some ten or fifteen feet in height, growing in dry and hilly situations. The same shrub in New York and Upper Canada, always inhabits miry swamps, and seldom attains to the height of a man. Its leaves and bark are remarkably smooth, and its branches delicate and brittle. The twigs and bark have a peculiar spicy flavour, and upon carefully heating them over a stove, the crystalline benzoic acid will rise as an odoriferous mist, and may be collected in cones of writing paper, in long splendid crystals.

Polygonae

Families of the rhubarb and dock. There are many vegetables that seem fond of the society of man, though they minister neither to his comfort nor necessities. They form their harmless colonies about his habitation, and when decay has crumbled it to the dust, they still point out the spot where it stood.

Among the self domesticated vegetables, may be reckoned several species of the *polygonum*. The knot grass, (*polygonum aviculare*), has a delicate knotted stem scarcely able to support itself. From alternate sides of the stem, proceed handsome light green leaves, terminating in a point, though their general form is oval. The tall knot grass, (*polygonum erectum*), very much resembles it. The latter, however, grows erect, and is much larger. The smart weed, (*polygonum barbatum*),[20] forms itself into little communities, and fixes its residence by the wayside and in neglected fields.

The ladies thumb, *polygonum persicaria*, resembles the smart weed in habit and appearance, but may be distinguished from it by a heart shaped spot of dark green on each leaf. There are two species of this family which grow near the water's edge, on the Muskingum river. They both have pale leaves and knotted stems. The larger species is called the mud knot weed; (*polygonum amphibium*),[21] the smaller, which may be distinguished by its narrow hairy leaves, has received the name of hairy knot weed, (*polygonum hirsutum*).[22]

The bread grass, (*polygonum sagittatum*), with its arrow form leaves and reversed prickles, abounds in damp places, its climbing stem easily supporting itself, among the bullrushes & ferns.

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[17]Later by correspondence changed to *Polygonum scandens* L. (*Aristolochiae* is the beginning of the September 8, 1832, list of plants.)

[18]*Sassafras albidum* (Nutt.) Nees.

[19]*Lindera benzoin* (L.) Blume.

[20]*Polygonum lapathifolium* L.

[21]var. *stipulaceum* (Coleman) Fern.

[22]Since this is a southern species, Riddell confused it with some other *Polygonum*.

The climbing buckwheat, *polygonum scandens*, whose leaves resemble those of the Virginia snakeroot, delights to grow on the borders of cornfields, and in the thickets of the pawpaw and elder. The halbert knot weed (*polygonum arifolium*),[23] is very rare.

The common field sorrel, (*rumex acetosella*), grows here in many situations, but the soil does not produce it very liberally. The peculiar acid taste of this plant depends upon a saline substance, whose basis is derived from the earth in which it grows. According to Bezrelius and others, this salt or sorrell is the potassic bi-oxilate; or caustic potash neutralized by the poisonous oxalic acid; notwithstanding, the leaves of sorrell are healthy and pleasant to the taste, and children are very fond of them.

In the course of my rambles I have observed three species of dock, (*rumex crispus, rumex obtusifolius, rumes acutus*),[24] another vegetable which replies upon the toleration of the husbandman and his herds, and quietly fixes itself in the most frequented fields.

Atriplices

The natural order including the beet, the blite, and the samphire. The pokeweed (*phytolacca decandris*),[25] grows in this part of Ohio in unparalleled abundance, and sometimes to a gigantic size. It is not unfrequent to see a thrifty poke towering above the neighbouring weeds and attaining the height of eight or ten feet. When the pokeweed is in flower, its appearance is not very interesting; the whole plant, the stem and flowers not excepted, partaking of a monotonous green color. Not so when the autumnal sun has elaborated and transformed the juices and matured the fruit. The stem then becomes a dark purple, the leaves as they are seized by incipient decay, acquire rich tints of crimson, varying into green, while the beautiful clusters of dark shining berries, may in appearance vie with any which the wilds produce. The juice of these berries, as well as an infusion of the membranous bark, makes a fine red dye. Unfortunately it is extremely fugacios, perhaps as little permanent as any we are acquainted with. In its medicinal capacity, the phytolacca acts both as an emetic and cathartic.

On the banks of the rivers and creeks, you will frequently meet with miniature forests of the Jerusalem oak, (*chenopodium botrys*). This plant attains to the height of ten or twelve inches, and from the arrangement of its branches and herbage, it bears a striking resemblance to a full grown oak. It awakens feelings and reflections of a peculiar cast, to wend one's way through a wilderness of the Jerusalem oak, and looking attentively down, to contemplate the aspiring forest trees so far below.

The common pigweed, (*chenopodium album*), manifests a great partiality for neglected gardens. It grows rapidly, and wilts almost instantaneously, if it be severed from its roots; both of which facts seem to show that the juice circulates with unusual rapidity.

Plantagines

The Plaintain. Of the humble but useful plantain, there are thirteen species growing in the United States. The smooth leaved plantain, (*plantago glabra*),[26] is the one which so plentifully abounds here. Its virtues are so well understood and appreciated, by the good housewife, as to preclude the necessity of dwelling upon them.

Lysimachiae

The loose strife, chick wintergreen, etc. The loose strife, (*lysimachia ciliata*), is a very regular herbaceous plant, with a profusion of bright yellow flowers; inhabiting the banks of rivers; & the low fertile meadows; and attaining the height of twenty or thirty inches. The footstalks of its leaves, are margined with straight hairs, resembling the eyelashes; and this circumstance distinguishes it from other species which nearly resemble it.

The chick wintergreen, (*trientalis americana*),[27] delights to grow in the most shaded parts of the primitive forests. In such situations, you will see its gay tuft of leaves, spreading out

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[23]Likely the var. *pubescens* (Keller) Fern.

[24]*R. conglomeratus* Murray.

[25]*P. americana* L.

[26]Since *P. eriopoda* Torr. not reported for Ohio, Riddell's plant was likely *P. major* L.

[27]*Trientalis borealis* Raf. (*Lysimachiae* is the beginning of the September 15 list.)

laterally from a stem a few inches in height, & decked perhaps with two or three delicate white flowers. Upon a hasty glance, one would suppose it were the red cherry tree, in an infant state; but observation would soon point out a dissimilarity. The only parts of the globe, where the chick wintergreen is known to grow, are Siberia and North America.

Pediculares

The lousewort, speedwell, etc. The barren snakeroot (*polygala ambigua*), may be found upon those arid hills, whose ferruginous soil has been formed from disintegrated rocks. This plant is so very small and delicate, as almost to escape observation. It may be known by its numerous branches, thickly crowded with pale green flowers.

Of the speedwells, I have observed only a small species, with smooth oval leaves, (*veronica serpyllifolia*). It inhabits very damp places. There is a family of herbs, which have received the name of lousewort from the fancied resemblance which their leaves bear, to the general outline of a louse. There is one species growing on the hills (*pedicularis lapponica*),[28] and one, among the brakes and sedges of the marshy ravine, near the giant mound, (*pedicularis pallida*).[29] Around the joints of the latter species, a frothy mucillage may sometimes be observed & occasionally a few other vegetable tenants of that ravine exhibit the same appearance. Upon examination, a small green worm may always be found, enveloped in the froth; but whether the liquid is secreted by the plant or the worm, or whether it is blown into bubbles by the wounded air cells of the one, or the singular ingenuity of the other, is questionable.

A tall plant known by the name of Culver's physic (*leptandria virginica*),[30] grows plentifully in the thickets of secondary growth, and not unfrequently in situations more exposed. At intervals of four or five inches, its straight and hollow stem is surrounded by five or six diverging leaves; and at the summit, the aggregated white flowers resemble a military plume. It is esteemed by some practioners, and excellent cathartic.

Acanthi

The water willow (*justicia pedunculosa*),[31] grows at intervals along the shores of the Muskingum river, taking root on the steep declivities, left dry by the subsidence of the vernal floods. This herbaceous plant, has numerous tufts of cheerful red flowers, elevated on slender stems, which are nearly equal in length, to its willow-like leaves. The water willow seldom exceeds two feet in height. It acts medicinally as an emollient.

Jesmineae

The white ash, (*fraximus accuminata*), is[32] occasionally met with in the forests, though it must be considered scarce. As a forest tree it is remarkably erect and graceful, carrying its principal stem much higher than the oak or the elm, and contributing by its agreeable foliage and light gray bark, to variegate and enliven the woodland scenery. Gilpin, in his work on the Forest scenery, says a writer on timber trees, calls the oak the Hercules of the forest, and the ash the Venus; the chief characteristic of the one being strength, of the other elegance. "The ash, however, drops its leaves very early; and, instead of contributing its tint to the many coloured foliage of the autumnal woods, it presents wide blanks of desolate boughs." The ash has been called "the Husbandman's tree, nothing being equal to it for agricultural implements, & for all sorts of poles, ladders, lughandles and other purposes which require strength & elasticity combined with comparative lightness." The prim, (*ligustrum vulgare*), has probably been introduced.

Vitices

The Vervains. The nettle-leaved vervain (*verbena urticifolia*), may be found on the borders of forests, in pastures, and on the commons in great plenty. It is a slender weed, growing three

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[28] Likely mistaken for *P. canadensis* L.

[29] *P. lanceolata* Michx.

[30] *Veronicastrum virginicum* (L.) Farw.

[31] *Justicia americana* (L.) Vahl.

[32] *Fraxinus americana* L.

or four feet high, with a four sided hairy stem, which is very much branched, and crowded with a profusion of small flowers that are pale and homely. Its leaves resemble those of the nettle, whence its name.

The blue vervain, or simpler's joy (*verbena hastata*), though it is closely and obviously allied to the preceding, is a much more graceful plant. I have seen it only upon the island near Marietta, and even there, it is met with so rarely, that it can hardly be considered as a native of the soil. It is an abundant product of more northern climates; and probably its seed has been transported by the floods from the elevated sources of the Allegheny. It may be known by its handsome serrate leaves, and clustered spikes of dark purple flowers. The vervains were considered by Parkinson, and the older authors, as efficient antidotes to the poison of serpents.

Labiatae

The mints and thymes. This natural order includes a great variety of interesting and useful herbs, which grow in all situations, and endure all climates: loading the air with their perfumes, and enlivening the desert place with their presence. They furnish the prudent mother with the most simple and valuable remedies & if you enter the abode of the industrious tenant, or the more comfortable mansion of the farmer, you will commonly see dried bundles of these herbs, plentifully suspended from the walls. Physicians in ancient times seem to have drawn a large portion of their *materia medica* from plants of this order. Speaking of them, in reference to their medicinal qualities, a late writer on botany, observes that "they are very active scernant stimulants, and among them, are all the most valuable sudorifics. The sweet scented are warming stomachics, and the bitter ones are tonics."

The water horehound, (*lycopus europaeus*),[33] grows on the banks of rivers & creeks and bears some resemblance to the northern mint. It differs, in having jagged leaves, and sessile rings of flowers that are much more minute.

The *lycopus virginicus*, growing on Duck Creek resembles the preceding. I have observed a species of *lycopus* upon the Muskingum river, which does not seem to be described in any *flora* which I have examined. I have avelled it in my collection, the *lycopus serratus*.[34] The leaves are notched upon their margins, and not lobed; and they seem much inclined to exchange their green for a hue of reddish brown.

Some of the mountain mints, all tall and extremely beautiful, appearing in all the intermediate tints between the deepest crimson, and the fairest white. The fragrance which they exhale is grateful & diffuse itself to a distance around. They are sometimes called the wild balm; and as they grow in almost every thicket, they are unquestionably well-known. They can be distinguished by a bunch of long, curved flowers, that are usually seated upon the summit of the stem. I have seen five species, (*monarda didyma var. augustifolia*,[35] *monarda clinopodia, fistulosa, monarda hirsuta*,[36] *monardo rugosa*).[37]

The wild germander (*teucrium canadense*), forms social collections in fields of bramble, displaying bright red flowers and broad leaves, and liberally wasting an agreeable perfume. It grows two feet high.

The wild basil, (*pyenanthemum incanum*),[38] is still more prodigal with its fragrance. Its branching stems grow tall and slender, and have a rather gay and airy appearance. The wild basil may be known by the remarkable paleness of its younger leaves, which would lead one to suppose they were blighted or sprinkled with meal.

REMARK—The general reader will find nothing perhaps to interest him in the list of vegetable productions, which is here subjoined. The writer intended to continue the notice, after the manner of the preceding numbers; and this resolution would still be regarded, were he not about to leave Marietta.

The generic and specific names are those adopted in the fifth Edition of *Eaton's Manual* of Botany.

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[33] *L. americanus* is probably the species, instead of *L. europaeus*, which is not reported for Ohio.

[34] In correspondence with Hildreth, he changes his specimen to *L. virginicus* L.

[35] *Monarda didyma* L.

[36] *Blephilia hirsuta* (Pursh) Benth.

[37] Likely *M. clinopodia* L.

[38] *Pycnanthemum pycnanthemoides* (Leavenw) Fern.

Mints and Thymes. Nepeta Cataria, cat-mint. Habitual, Fields. *Hyssopus nepetoides*,[39] Giant hyssop. Hab–Woods. 5 feet high. *Mentha borealis*,[40] Northern mint. River banks. *M. Viridis*,[41] Spearmint. River banks. *M. piperita*, Pepper-mint. *Leonurus cardiaca*, Motherwort. *Marrubium vulgare*, Horehound. Plenty. *Cunila mariana*,[42] Dittany. Hills. *Hedeoma pulegioides*, Pennyroyal. Very abundant–Fields. *Glechoma hederacea*, Ground ivy-meadows, and *Scutellaria* lateriflora, Mad-dog-scull-cap-Low lands. *S. serratia* in thickets, and among briers. *Clinopodium vulgar*.[43] Field thyme—Emerson's ravine. *Prunella vulgaris*, Heal-all. Fields.

Scrophularia

The monkey-flower, fox-glove, etc. Dracocephalum virginianum,[44] Dragon's head—Duck Creek. *D. cordatum*,[45] Mile Run. *Scrophularia marilandica*, Figwort—Plenty—7 feet high. *Antirrhinum linaria*,[46] Toad flax—Elevated Square. *Gerardia flava*, False fox glove—Woods. *G. Pedicularia* Woods. *G. glauca,?*[47] (perhaps new). *Gerardia*, (undescribed?)[48]—Woods. *Mimulus ringens*, Monkey-flower—Muskingum banks—Rare. *M. alatus*—Plenty; damp places; 18 inches high.

Solaneae

Potato, Deadly night-shade, etc. Daturum strammoium var. *purpureum*. Thorn apple—Very abundant. 2 to 3 feet high. *Verbascus thapsus*, Mullein—tolerably plenty. *V. blattaria*, Moth mullein—2 feet. *Solanum nigrum*, Deadly nightshade—abundant every where. *Physalis viscose*,[49] Yellow henbane.

Boranginae

Cynoglossum pilosum,[50] Hairy hound-tongue—River banks; 3 feet high.

Convolvuli

Morning glory, and so forth. Convolvulus repens,[51] Field bindweed-Cornfields. *C. arvensis*—Cultivated lands. *Cuscuta americana*,[52] dodder—Plenty. (Stem twining, yellow and leafless.)

Bignoniae

Catalpas tree, snake-head, etc. Bignonia radicans,[53] Trumpet flower. *Chelone glabra*, Snake-head—marshy ravine.

Polemonia

The polemonium, lichnidia, etc. Phlox paniculata, Lichnidia—island in the Ohio river. *P. maculata*, Spotted stem. Lichnidia—Marshy ravine.

Apocyneae

Apocynum androsaemifolium, Dog bane, Wanderingmilkweed—among briers. *A. hyper-*

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[39] *Agastache nepetoides* (L.) Ktze. (*Labiatae* is the beginning of the September 22 list.)

[40] *M. arvensis* var. *villosa* (Benth.) S. R. Stewart.

[41] *Mentha spicata* L.

[42] *Cunila origanoides* (L.) Britt.

[43] *Satureja vulgaris* (L.) Fritsch.

[44] *Physostegia virginiana* (L.) Benth.

[45] *Meehania cordata* Brit.

[46] *Linaria canadensis* (L.) Dumont.—evidently *L. vulgaris* had not been introduced as yet.

[47–48] Probably one of the undescribed varieties of *G. flava* or *G. pedicularia* (L.) Farw.

[49] *Physalis heterophylla* Nees.

[50] In correspondence to Hildreth, Riddell calls this *Rochelia virginiana*. *Lappula texana* (Sch.) Brit. More likely to be *C. virginiaum* L.

[51] *C. sepium* var. *repens* (L.) Gray.

[52] *C. Polygonorum* Engelm.

[53] *Campsis radicans* (L.) Seeman.

icifolium,[54]—River banks. *Asclepias syriaca*, Common milkweed (Silgrass). *A. incarnata*, Purple milkweed. *A. nivalis*,[55] *A. tuberosa*, Butterfly weed—in meadows.

Gentiana

Sabatia angularis, American century—1 foot high; lands recently cleared.

Rhododendra

Kalmia latifolia, Laurel—1 mile west from Point Harmar. *Diospyros virginiana*, Persimmon.

Ericae

Pyrola dentata[56]—Open woods. *Chimaphila maculata*, Spotted wintergreen—Laurel hill; Pine woods. *Vaccinium corymbosum*, Giant whortle berry—Laurel hill. *V. virgatum*,[57]—Ravine. *Andromeda arborea*,[58]—Sorril tree, 20 feet high—Plenty. *Monotropa uniflora*, Indian pipe—Woods; 6 inches high; whole plant white.

Campanulaceae

Lobelia inflata—Indian tobacco—Plenty in fields and forests. *L. kalmii*[59]—Ravine. *L. siphilitica*—Woods; Plenty. *L. cardinalis*, Cardinal flower—seems rare. *L. fulgens*[60]—Woods and rank thickets; 3 feet; slender.

Cichoraceae

Leentodon taraxacum.[61] Dandelion. *Prenanthes virgata*,[62] Wild lettuce. *Sonchus floridamus*.[63] Gall of the earth. 4 feet high.

Cinarocephalae

Liatris grammimfolia,[64] a beautiful flowering bulbous plant. 3 feet high; rare on sandy hills. *Cnicus lancelotus*,[65] Common thistle, not plenty. *C. altissimus*, Fall thistle; 10 or 12 feet. *Arctium lappa*, Burdock; probably introduced.

Corymbiferae

Bidens frondosa, Burr-marygold; not abundant. *B. bipinnata*, Hemlock beggar-ticks; plenty on new land. *Kuhnia eupatorioides*,[66] False boneset. *Eupatorium perfoliatum*, Boneset; thoroughwort: abundant *E. sessifolimun*, Dry forests; 3 feet. *E. purpureum*, Joe-pye; plenty; 8 feet. *E. muskingi*,[67] Ironweed (not described in Eaton?) *Cacalia suaveolens;* 4 feet high; Island and river bank. *C. radiata*,[68] (non-descript?) 5 or 6 feet high; sandy soil; Emerson's ravine. *Gnaphalium americanum*,[69] Life everlasting; 12 inches, woods and open places. *G.*

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[54]*A. sibiricum* Jacq.

[55]In correspondence with Lee Walp, August 10, 1950, Dr. M. L. Fernald suggests that Riddell's plant was *A. perennis* or *A. quadrafolia* rather than *A. nivalis*.

[56]Hildreth correspondence, leaves of Erigeron and capsule of Pedicularis. (sic.)

[57]*V. vacillans* Kalm.

[58]*Oxydendrum arboreum* (L.) D.C.

[59]Hildreth correspondence changed to *L. claytonia* which now is *L. spicata* L.

[60]Hildreth correspondence changed to *Campanula americana* L.

[61]*Taraxacum officinale* Weber.

[62]*P. autumnalis* Walt.

[63]*Lactuca floridana* (L.) Gaertn.

[64]*L. cylindracea* Michx.

[65]*Cirsum vulgare* (Savi) Tenòre.

[66]Later changed to *E. ageratoides*. Now known as *E. rugosum* Howtt.

[67]Changed to *Veronia praealta*, which should have been *V. noveboracensis* L. 1753.

[68]Hildreth correspondence changed to *C. reniformis*, which in turn was likely *C. Muhlenbergii* (Sch. Bip.) Fern.

[69]*G. purpureum* L.

polycophalum, Sweet balsam;[70] 2 feet, pastures. *Chrysanthemum leucanthemum*,[71] Oseyed daisy; abundant in meadows. *Inula helenium*, Elecampane. *Erigeron canadense*, Flea bane. *Solidago stricta*, golden rod. *S. latifolis*,[72] *S. virgata*,[73] *Aster aestivus*,[74] Star flower.*A. solidaginoides*,[75] *A. macrophyllus. A. prenanthoides. Anthemis cotula*, [76]May weed; very common. *Achillea millefolinum*, Yarrow. *Rudbeckia aristata*. Cone flower, 2 feet dry places. *R. digitata*[77]—8 feet, low situations. *Helianthus mollis*. Wild Sunflower. *H. altissimus*,[78] *H. longifolius. H. sparsifolius*,[79] *H. truncatus*,[80] *H. rigidus* (nondescript?)[81] *Coreopsis tripteris*, Tickseed-sunflower, 6 feet high. *Actinomeris squarrosa*,[82] feet, Plenty.

Dipsaceae

Cephalanthus occidentalis, Button bush; marshes.

Caprofolia

Viburnum dentatum. Arrow wood; under shrub, 6 feet high. *V. molle;* Woods; rare-*Sambucus canedansis*, Sweet elder; plenty. *S. pubescens*, red berried elder; more scarce—*Cornus florida*, Dogwood; in forests very abundant. *C. asperifolia*,[83] not plenty. *Triosteum perfoliatum*, Horse ginseng; occasionally met with.

Rubiaceae

Galinum micranthum, Bed straw, a delicate vine. *G. tinctorium*, Dyer's cleaver. *G. circoezans*, Wild licorce. *G. aparine; G. pilosum; Houstonia caerulea*, Venus' pride; seems rare. *H. purpurea;* more plenty.

Araliae

Panax quinquefolia, Ginseng; tolerably plenty. *Aralia racemosa*, Spikenard; plenty. *A. nudicaulis*, Duck Creek, *A. spinosa*, Agelica tree; 15 feet high.

Umbelliferae

Cicuta maculata, Glaucous Hemlock deadly poison; Emerson's ravine. *Uraspermun claytoni;*[84] Sweet cicely Woods; rare.

Ranunculaceae

Actea rubra,[85] Baneberry; 6 feet; plenty. *Macrotys racemosa*,[86] Cohosh; Woods, rare; resembles the preceding. *Podolphyllum peltatum*, May apple, *Aquilegia canadensis*, Wild columbine, *Hydrastis canadensis*, Orange root. *Clematis virginica*, Virgin's bower, *Caulophyllum thalictroides*, Poppose root; woods. *Thalictrum dioicum*, Meadow rwe. *C. corynellum*,[87] *C.*

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[70]*Gnaphalium obtusifolium* L.

[71]Probably the variety *pinnatifidum* Lecoq & Lamotte.

[72]*Solidago flexicaulis* L.

[73]*Solidago stricta* Ait.

[74]This could be any of the narrow leaf asters common to Ohio.

[75] *A. linifolius* (L.) B.S.P.

[76]*R. triloba* L.

[77]*R. laciniata* L.

[78]Probably *H. giganteus* L.

[79]*H. atrorubens* L.

[80]*H. divaricatus* L.

[81]Rare in E.U.S. (?) Likely a name used by Riddell for a Helianthus that he was unfamiliar with.

[82]*Actinomeris alternifolia* (L.) D.C.

[83]*C. Drummondi* Meyer.

[84]*Osmorhirza Claytoni* (Michx.) Clarke.

[85]*Cimicifuga racemosa* (L.) Nutt.

[86]*A. pachypoda* Ell. 85–86 are interchangeable.

purpurascens.[88] *C. carolinianum*,[89] *Anemone virginiana*, Wind flower; 2 feet *Hepatica americana* var. *acutiloba*,[90] Liver leaf; woods, *Ranunculus recurvatus* Woodland crow foot;—Woods, Renivalis

The September 22 newspaper concludes with the following editorial note:

Note: The scarcity of periods and commas, must account for the erroñeous punctuation. and to be concluded in the next issue.

The last portion of Riddell's report undoubtedly contained the *Roseaceae*, *Leguminosae*, *Cruciferae*, *Hypericaceae* and *Caryophyllaceae*, etc. From these families, it would have been possible for him to have collected the 250 plants that he set out to sell to his clients.

The following two letters from Worthington, Ohio, written by Riddell to Hildreth help to complete his report. The following few lines are taken from the first letter dated October 24, 1832.

I have been paying some attention to my herbarium and I find that haste, imperfect specimens, and too much reliance on memory, had favoured the introduction of some errors. Please change the name *Macrotys racemosa* to *Actaea alba*, *Acteae rubra* to *Macrotys racemosa*, *Aster aestivalis* to *Erigeron*. Among the nameless plants which I left you, there is a brier I learned *Labiate* plant, growing in the woods called rich-weed, horse-balm, etc. It is a collinronid. The one with triangular capsules, and cordate leaves, which Peter took to be a Menis permum, is a *Dioscorea*.

The second letter dated September 5, 1833, is quoted in part and contains Torrey's corrections for the plants Riddell collected in Marietta.

As yet, I find much to interest me in the Prairies on every side. I sent to Torrey my doubtful plants up to May last, and have just received a letter from him, so that I am now able to correct some errors, in the herbarium which you have. Change *Nyptis eradiata* to *Collinsia verna*, *Anemone onlentangiensis* to *Enemion biternatum* Raf. (not mentioned in Eatons?) Dr. Torrey thinks it is really the *Isopyrum thalictnoides* Lin.,[91] a plant which inhabits the central portions of Europe, *Aethusa leptophylla?* is *Ergenia bulbosa* Nutt. As I am conscious now, of having committed some errors in labeling those plants which I left with Mr. French and others, I will thank you to submit to them the following corrections.

Aletris aurea is—*Veratrum luteum* Tor.
Aristolochia serspentaria—Polygonum scandens.
Lycopus serratus—L. virginicus.
Gerardia pedicularia—G. flava, a variety of.
Cynoglossum pilosum—Rochelia virginiana.
Pyrola dentata—Erigeron (leaves) and *Pedicularis* (capsules).
Lobelia fulgens—Campanula americana.
Lobelia kalmii—L. claytoniana.
Kuhnia euratoraides—Eupatorium ageratoides.
Eupatorium muskingi—Vernonia praealta.
Cacalia radiata—C. reniformis.
Helianthus sparsifolius—Heliopsis laevis.
Coreopsis trichosperma—C. tinctoria.
Actaea rubra—Macrotys racemosa.
Thalictrum corynellum—T. revolutum.
Cucubalus stelltus—Lysimachia quadrifolia.
Cerastium vulgatum—Gnaphalium plantaginifolia.

[87–88]These two leave one in doubt as to what *Ranunclaceae* Riddell had in mind.
[89]Likely *Delphinium carolinianum.*
[90]*H. acutiloba* D. C.
[91]*Isopyrum biternatum* (Raf) T. & G.

Potentilla fruticosa—Agrimonia parviflora.
Potentilla anserina—Agrimonia eupatoria.
Hedysarum humifusum—Clitoria mariana Tor.
Lespedesa divergens—Hedysarum strictum.
Lespedesa vidacea—H. paniculatum.
Melothria pendula—Lycopus angulata.
Urthica pumila var. *nulcata—Boehmeria lateriflora.*[92]

Among the plants[93] I sent you by Dr. Cotton, the one labelled '.unknown shrub–' is either *Cornus paniculata* or *Rhus aromatica*, the latter if it has ternate leaves. *Baptisia coerida* is *B. alba.* (I have not seen the flowers). *Oenothera new?* is *Gaura mollis.* '.Unknown thyme, is *Pycnanthemum virginianum, Elaeagnus aregentea* is *Lepargyraea canadensis.*[94] *Lobelia dortmanna* is *L. Kalmii. Ribes* is *Ribes hirtellum.* Black haw is the *Viburnum prunifolium. Hypericum kalmianum* is *H. prolificum.*[96] *Euphorbia cordifolia*, is *Euphorbia obtusata.*

It is unfortunate that the Hildreth Herbarium, which would have included Riddell's plants mentioned in the *Western Republican*, was not cared for when it was given to Marietta College. Since the collection is not available, the list he published is the next best thing, for it not only gives us the earliest plant list for Ohio, but also furnishes some information as to the first introduced plants which had become established as weeds. It is not surprising that the insects reduced the Hildreth Collection to powder, for, at that time, the only interest in botany was the work of the geologist, E. B. Andrews. His collection was of a more durable nature because it contains many type specimens of fossil plants that he collected while working for the Ohio Geological Survey. Even some of these fossils were in a poor state of preservation. In the early 1920's Professor H. R. Eggleston found that Hildreth's insect collection had met a similar fate. A few years later Professor R. W. Whipple located Hildreth's clam collection and his journal listing minerals, insects, clams and curios in his collection. This journal did not list any plants other than a few fossils. Since Riddell worked for Hildreth a couple of summers as field geologist, and since he collected fossil plants and clams, it may be that some of his unlabeled fossil specimens got into the Andrews Collection, and that some of the clam shells in the Hildreth Collection were actually collected by Riddell.

Since Marietta College does not have a set of Kew Indices, the author was obliged to consult the late Dr. Fernald of the Gray Herbarium, Dr. Rogers McVaugh of the University of Michigan Herbarium, Dr. Clara Weishaupt of the Ohio State Herbarium, and Dr. Clarence Kohiski of the Arnold Arboretum in connection with the early nomenclature of several of the plants in question.

In spite of our conclusions, the reader is free to disagree, because there are no plants to substantiate Riddell's list. There will be some who will think that the list is worthless without specimens, but the author takes the attitude that even a newspaper list is better than nothing at all, especially when it was made by a reputable Botanist. For more detailed information concerning the life of Riddell, one should read Dr. Waller's (1945) most interesting papers from which I have drawn freely.

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[92] *B. cylindrica* (L.) Sw.

[93] These may have been plants collected around Worthington, Ohio, rather than Marietta plants. Most of them do not appear in his original newspaper list, and note that they were sent to Marietta by Dr. Cotton. Several have not been recorded for Washington County.

[94] *Shepherdia canadensis* (L.) Nutt.

[95] *H. spathulatum* (Spach.) Stewd.

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Larvae of Insects, Part II—Coleoptera, Diptera, Neuroptera, Siphonaptera, Mecoptera, Trichoptera. *Alvah Peterson.* Edwards Brothers, Inc. Ann Arbor, Michigan. First Edition. 1951. v+416 pp. **$7.00.**

One of the phases of insect taxonomy which has been greatly neglected is the study of the immature insect stages. In volumes I and II of "Larvae of Insects" the author has attempted to bring together all of the known material in one portion of that field. Volume I, published in 1948, treats in detail the larvae of Lepidoptera and Hymenoptera. Volume II, now just appearing in print, treats in a similar manner the larvae of Coleoptera and Diptera, and in less detail the larvae of Neuroptera, Siphonaptera, Mecoptera, and Trichoptera.

A discussion is presented of the larval characters of each order and the structures which differentiate the members of the different families. Following this, in all orders except the *Siphonaptera* and *Mecoptera*, a key is presented for identifying the larvae of the common families and an excellent set of figures to illustrate the characters used in the keys. In each group is a selected bibliography. The final portion of the publication contains a well planned glossary; a food, host, or habitat index for both Coleoptera and Diptera and a general index.

The compilation of material is exhaustive, the organization excellent, and the wealth of accurate illustrations is an outstanding contribution to this field of study. Several years of careful and meticulous work have been performed by the author in supplementing, with a large amount of original research, work previously published by others.

The text and its companion volume contain a complete summary of known larval types and larval characters and, in its present form, has been used by the author as a text for the study of insect larvae. The publication is an indispensable manual for any entomologist as it is the only up to date compilation of material in this field.

DWIGHT M. DELONG

NOTES ON THE REPTILES AND AMPHIBIANS OF GREENE COUNTY, OHIO

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About five years have passed since the author became interested in the reptiles and amphibians of Greene County. Since that time there has been some collecting in nearly every part of the county, and many accessible areas have been collected heavily. A large number of specimens has been preserved in the collections of Antioch College at Yellow Springs; in the Dayton Public Library Museum; in the collection of J. T. Wood; and in my own collection.

I wish to express my thanks to Dr. Henry Federighi of the Biology Department of Antioch College and to Mr. C. A. Barker, director of the Dayton Public Library Museum, for permission to examine the preserved material in those institutions. Mr. J. T. Wood has kindly supplied me with data from his Greene County specimens, has added to the field notes on many species, and has read this manuscript. Mr. Karl P. Schmidt has also offered many helpful suggestions. The map of Greene County was drawn by Mr. John E. Flynn of the University of Michigan. For their invaluable field assistance I am indebted to many members of the Dayton Society of Herpetology; especially: Richard R. Knotts, Harold J. Walters, Richard S. Brown, and Mr. and Mrs. Doyt E. Ladd.

When the work on Greene County was begun, the county was relatively little known herpetologically. Conant (1938) reported 13 forms of reptiles from the county, and Walker (1946) added six forms of amphibians. Wood (1945a) and Wood and Duellman (1947a) added two more species to the list, bringing the total to 14 reptiles and seven amphibians. It is the purpose of this report to bring this list of species up to date and to supplement this with field notes.

Greene County lies in the glaciated till plains of southwestern Ohio (fig. 1). It is drained for the most part by the Little Miami River, which flows south through the western part of the county, and its tributaries. It is also partially drained by the Mad River, which flows through the northwestern part of the county. Both of these rivers flow into the Ohio. Throughout most of the county the physiography is that of the typical rolling land of the till plains. There are, however, two definite exceptions. The most striking is the deep gorge cut by the Little Miami River in the northern part of the county. The other is a marshy area in the northwestern part of the county. This area, Huffman Prairie, has undergone extensive drainage in the last decade, which has probably brought about a considerable change in the faunal distribution in this area. At one time Greene County was part of the great oak-hickory forest, but when the land was settled it was soon cleared and farmed. Thus, today there is very little natural forest left in the county. There are small woodlots in the corners of farms, and in some areas unsuitable for farming there is some natural forest. However, the greatest part of the land is farmed or used for pasture. The Clifton Gorge area and John Bryon State Park are the only large forest reserves left in the county.

Several species known from surrounding counties were not found in Greene County during the course of our collecting. Following is an annotated list of the species that were not found in the county, but have been recorded by various authors from surrounding counties or have been preserved in one of the cited collections. *Necturus m. maculosus* and *Cryptobranchus a. alleganiensis* have been found in the Mad River in Montgomery County (Wood and Duellman, 1947b). During the early spring of 1949 and 1950, a special attempt was made

to find various species of *Ambystoma*, but suitable breeding ponds were not to be found in the county. *Ambystoma texanum* (reported as *A. jeffersonianum*) has been found to be abundant in parts of Montgomery County (Wood and Duellman, 1947b). *A. jeffersonianum* and *A. maculatum* have been collected to the south in Warren County, and King (1935) reported *Ambystoma opacum* from Clinton and Warren Counties. *Desmognathus f. fuscus* has been found in Montgomery County (Wood and Duellman, 1947b), but collecting in likely places in Greene County has not revealed this species. *Plethodon c. cinereus* is very common in most of the surrounding counties, but none have been recorded from Greene County, even though in the spring of 1950 most of the woodlots in the county were systematically searched for this species. It is interesting to note that *Plethodon*

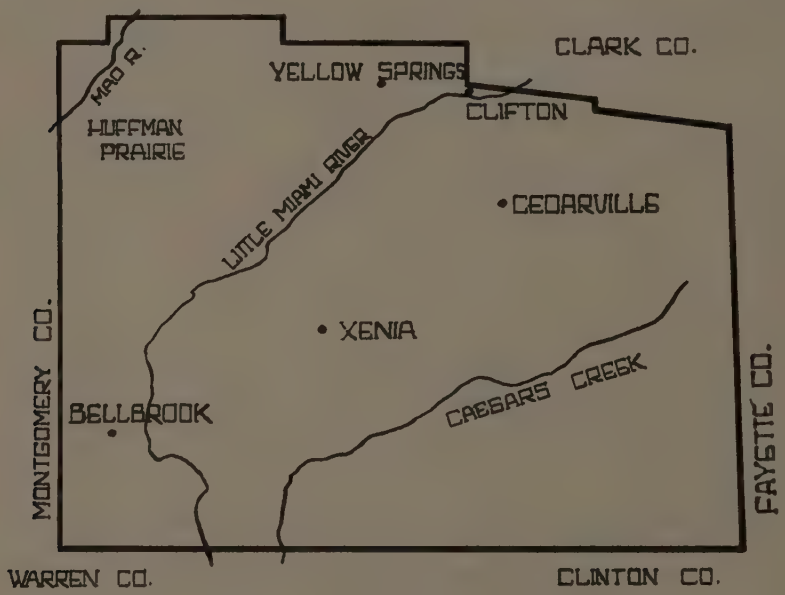

FIGURE 1. Map of Greene County, Ohio.

richmondi is much more abundant in Greene County than in any of the surrounding counties. In places in Montgomery County *Plethodon c. cinereus* and *Plethodon richmondi* may be collected on the same woodland slope; yet, only *Plethodon richmondi* can be found in the same situations in Greene County. Walker (1946, p. 98) reported *Rana s. sylvatica* from Warren and Clinton Counties. As for lizards, *Eumeces fasciatus* has been found in Warren and Clark Counties, and *Eumeces laticeps* (reported as *E. fasciatus*) has been collected in Montgomery County (Wood and Duellman, 1947b). Only two snakes known from surrounding counties have not been found in Greene County: *Heterodon p. platyrhinos* in Montgomery County (Wood and Duellman, 1947b), and *Opheodrys v. vernalis* in Fayette County (Conant, 1938, p. 47).

Following is an account for each of the species known from the county with notes on habitat and life history when available. All known locality records represented by preserved specimens are listed.

Ambystoma tigrinum tigrinum (Green). One specimen in the collection of J. T. Wood was collected from a leaf-filled cellar stairwell at Yellow Springs, Miami Twp., in September 1946 by an Antioch College Student.

Plethodon richmondi Netting & Mittleman. This species has been found to be very abundant in many areas in the western part of the county, especially at Glen Helen, Yellow Springs, Miami Twp. (fig. 2). Here there are several small ravines from which streams flow into the Little Miami River. At the rims of these ravines are limestone outcroppings, the upper formation of which is the Cedarville. Beneath this is the Springfield, which weathers more quickly. Thus, an undercut has been formed beneath the Cedarville. From the Springfield formation sloping downward to the stream beds are wooded talus slopes. On these slopes *Plethodon richmondi* is abundantly found under limestone slabs lying on or imbedded in the talus. The great majority of the specimens have been collected between mid-October and the last of May, and only about a half a dozen specimens have been taken during the warm months. Collecting in hot weather has usually failed to reveal this species, but at certain times in the winter months it appears to

FIGURE 2. Talus slope at Glen Helen near Yellow Springs. Habitat of *Plethodon richmondi*.

be abundant. Three juveniles collected April 7, 1949, were evidently young of the previous year. Wood (1945b) reported *Plethodon richmondi* in this area to have very large ovarian eggs during late April and May; so, the species must lay its eggs in late spring or early summer, meaning that they should hatch in late summer or autumn. County records are: Glen Helen, Yellow Springs; and Clifton Gorge, Miami Twp.; 2 miles south of Zimmerman and one and a half miles south of Alpha, Beaver Creek Twp.; one and a half and two and one-half miles northwest of Xenia, Xenia Twp.

Eurycea bislineata rivicola Mittleman. This appears to be the most common salamander in the county and has been found every month of the year. During the winter months specimens may be collected in the vicinity of springs (fig. 3.) Scores of specimens were collected in the winter of 1948, and it was noted that a large percentage of these were females containing ovarian eggs. The species has been found in a variety of habitats, but springs and their immediate vicinity usually support large populations. Specimens have also been taken in small rocky streams, and during the winter many larvae have been found under water cress in spring seepages. The species has been found in close association with *Eurycea l. longicauda*. County records are: Yellow Springs and Clifton Gorge, Miami Twp; Bellbrook, Sugar Creek Twp.; three and one-half miles northwest of Xenia and 2 miles south of Zimmerman, Beaver Creek Twp.

Eurycea longicauda longicauda (Green). This active species is common in certain localities in the vicinity of springs and small rocky streams. By way of exception a number of specimens were found under limestone slabs on talus slopes in late spring. At this time the streams contain much water, and the slopes are moist due to spring rains. In July, specimens were found at dusk crawling on a moist wall by a small cascade. This species has been found at: Yellow Springs and Clifton Gorge, Miami Twp.; Bellbrook and Sugar Creek one and one-half miles northwest of Bellbrook, Sugar Creek Twp.; one and one-half miles and two and one-half miles northeast of Xenia, Xenia Twp.; and Cedarville, Cedarville Twp.

Bufo terrestris americanus (Holbrook). The Dayton Public Library Museum has two specimens: one each from Yellow Springs and Clifton, Miami Twp. Walker (1946, p. 32) reported the species from Xenia, Xenia Twp., and from Clifton.

Bufo woodhousii fowleri Hinckley. One specimen in the collection of J. T. Wood bears the data: Yellow Springs, Miami Twp., August, 1946.

Acris crepitans Baird. This species is most often found in marshy areas and along the edges of ponds. No specimens were taken far from water. Walker (1946, p. 38) reported the species

FIGURE 3. Spring seepage near Yellow Springs. Habitat of *Eurycea bislineata rivicola* and *Eurycea l. longicauda*.

from Clifton, Miami Twp. Other localities are: Yellow Springs, Miami Twp.; Bellbrook, Sugar Creek Twp.; Beaver Creek Twp.: three and one-half miles northwest of Xenia and 2 miles west-northwest of Xenia.

Pseudacris nigrita triseriata (Wied) J. T. Wood has specimens from near New Germany, Beaver Creek Twp., collected in May 1947. Mr. H. J. Walters has told me of hearing a loud chorus of these frogs in April 1949 at the same locality. No specimens have been seen other than in the spring months.

Hyla crucifer crucifer Wied. Walker (1946, p. 60) recorded this species from Trebein, Beaver Creek Twp.

Hyla versicolor versicolor (Le Conte). The tree frog has been found in chorus on June 14, 1942, by J. T. Wood and on June 9, 1950, by myself. Large numbers were found at a pond in a gravel pit 2 miles west-northwest of Xenia. The species has also been taken at Alpha, Beaver Creek Twp.; and Yellow Springs, Miami Twp.

Rana catesbeiana Shaw. This species was taken by Wood at Glen Helen, Yellow Springs, Miami Twp. He informed me that the bull frog can be heard calling from the lake in the glen on most warm nights during the summer.

Rana clamitans Latreille. This species is found in a great variety of habitats: rocky streams, springs, ponds, and marshy areas usually in or near wooded areas. On a warm July evening several specimens were found in small holes in a limestone outcropping, where there was a small cascade. The holes were barely large enough to house a single frog. There are specimens from Yellow Springs and Clifton, Miami Twp.

Rana palustris Le Conte. Walker (1946, p. 84) reported this species from Clifton, Miami Twp.

Rana pipiens pipiens Schreber. Common along the margins of grassy streams and ponds, this species is thought to be abundant over the entire county. Locality records are: Yellow Springs and Clifton, Miami Twp.; Caesar's Creek and one and one-half miles northeast of Xenia, Xenia Twp.; also reported by Walker (1946, p. 91) from Xenia ,Xenia Twp.

Carphophis amoenus helenae (Kennicott). Morse (1904) reported this species from Yellow Springs. Subsequent collecting has not revealed another specimen.

Diadophis punctatus edwardsii (Merrem). Conant (1938, p. 39) reported this species from Yellow Springs. Recently, two specimens were collected on talus slopes inhabited by *Plethodon richmondi*. H. J. Walters reported that he has taken two specimens near Bellbrook, Sugar Creek Twp., but unfortunately none were preserved. Locality records: Glen Helen, Yellow Springs, Miami Twp.

Coluber constrictor constrictor Linnaeus. (Specimens of this snake appear to be intergrades between *Couber constrictor constrictor* and *Coluber constrictor flaviventris*.) This snake has been found more often in the vicinity of farms and meadows than in woodlands. Wood reported a specimen collected near New Germany that was swallowing a large *Thamnophis o. ordinatus*. Specimens in the collections are from: Bellbrook, Sugar Creek Twp.; 1 mile south of Fairborn, Bath Twp.; near New Germany, Beaver Creek Twp.; and two and one-half miles northeast of Xenia, Xenia Twp. Conant (1938, p. 52) reported the species from 3 miles west of Xenia, Xenia Twp.

Elaphe obsoleta obsoleta (Say). This species is not uncommon in the county. Locality records are: Yellow Springs, Miami Twp.; Bellbrook, Sugar Creek Twp.; and Xenia, Xenia Twp.

Lampropeltis doliata triangulum (Lacepede). The secretive habits of this snake render it hard to find, but the species is not thought to be scarce. Specimens in the collections are from: Yellow Springs, Miami Twp.; 3 miles west of Yellow Springs, Miami Twp.; near New Germany, Beaver Creek Twp.; 2 miles north of Zimmerman, Beaver Creek Twp.; and one and one-half miles northeast of Xenia, Xenia Twp. Conant (1938, p. 68) reported the species from 3 miles west of Xenia, Xenia Twp.

Natrix kirtlandii (Kennicott). One specimen collected at Xenia, Xenia Twp., on April 4, 1941, was found under a board in a well-drained meadow about twenty feet from a brook behind the state fish hatchery.

Natrix septemvittata (Say). This snake is abundant along swift-flowing, rocky streams fringed with willows, and can be found along most creeks and rivers (fig. 4). It is less pugnacious than *Natrix s. sipedon*, but uses its musk glands freely. Locality records are: Yellow Springs and Clifton, Miami Twp.; Bellbrook and Sugar Creek one and one-half miles northwest of Bellbrook, Sugar Creek Twp.; Alpha, Beaver Creek Twp.; Beaver Creek Twp.: three and one-half miles northwest of Xenia; and Caesar's Creek, Xenia Twp. Conant (1938, p. 79) reported the species from Yellow Springs, Miami Twp.; Oldtown and 2 miles north of Oldtown, Xenia, Twp.

Natrix sipedon sipedon (Linnaeus). Found in a variety of habitats ranging from springs and rocky streams to lakes and marshes, this species is never found far from a permanent body of water. Specimens in the collections are from: Yellow Springs and Clifton, Miami Twp.; Bellbrook and Sugar Creek one and one-half miles northwest of Bellbrook, Sugar Creek Twp.; Alpha, Beaver Creek Twp.; Caesar's Creek and two and one-half miles northeast of Xenia, Xenia Twp. Conant (1938, p. 83) recorded the species from Yellow Springs, Miami Twp.; Oldtown and 2 miles north of Oldtown, Xenia Twp.

Storeria dekayi dekayi (Holbrook). (Specimens of this snake appear to be intergrades between

Storeria d. dekayi and the mid-western subspecies, *Storeria d. wrightorum*.) A specimen in the Dayton Public Library Museum bears the data: Huffman Prairie, Bath Twp., March 26, 1939. Conant (1938, p. 90) reported the species from Spring Valley, Spring Valley Twp.

Thamnophis butleri (Cope). Conant (1938, p. 98) reported this snake from Clifton Gorge, Miami Twp. and from 4 miles north of Xenia, Xenia Twp. A specimen recently brought into the Dayton Public Library Museum was from Huffman Prairie, Bath Twp.

Thamnophis ordinatus ordinatus (Linnaeus). Found mostly in the vicinity of streams and marshes, this snake appears to be common during the mating season in the early spring. Locality records are: Yellow Springs, Miami Twp.; Beaver Creek Twp.: three and one-half miles northwest of Xenia, Alpha, Trebein, and New Germany; 3 miles southwest of Cedarville, Cedarville Twp.; and one and one-half miles northeast of Xenia, Xenia Twp. Conant (1938, p. 105) reported the species from Yellow Springs, Miami Twp. and 2 miles north of Xenia, Xenia Twp.

Sistrurus catenatus catenatus (Rafinesque). Formerly, this species was reported common in the prairie-marsh area in the northwestern corner of the county. This area, Huffman Prairie,

FIGURE 4. Little Sugar Creek near Bellbrook. *Natrix s. sipedon* and *Natrix septemvittata* are found here.

has been extensively drained by the army. Wood found a specimen dead on the road at Patterson Field, Sept. 17, 1940; and on June 15, 1941, he collected a living specimen in the marsh on a grass hummock surrounded by water. In the Dayton Public Library Museum there is a specimen from Huffman Prairie, Bath Twp. This specimen had swallowed a *Storeria d. dekayi*. Recently, I examined a specimen killed on July 19, 1949, at Huffman Dam, Bath Twp. The species is still found in reduced numbers in this area; although, it is evidently less abundant than prior to the drainage. Conant (1938, p. 114) reported the species from Fairborn, Bath Twp.

Sternotherus odoratus (Latreille). J. T. Wood reported this species from Glen Helen, Yellow Springs, Miami Twp.

Chelydra serpentina serpentina (Linnaeus). Conant (1938, p. 125) reported this species from Yellow Springs, Miami Twp. Wood also reported it from Yellow Springs Brook and Lake Helen, Glen Helen, Yellow Springs.

Clemmys guttata (Schneider). J. T. Wood has a specimen from Trebein, Beaver Creek Twp., collected June 20, 1947, in a small tributary to the Little Miami River. Subsequent collecting has not revealed another specimen.

Terrapene carolina carolina (Linnaeus). There is a specimen in the Dayton Public Library Museum from John Bryon State Park, Miami Twp. Wood reported the species from Glen Helen, Yellow Springs, and Clifton Gorge, also in Miami Twp.

Graptemys geographica geographica Le Sueur. J. T. Wood reported a specimen from Little Beaver Creek near Alpha, Beaver Creek Twp., and one from Grinnell's Mill, Little Miami River, Miami Twp.

Chrysemys picta marginata (Agassiz). Specimens have been observed in pools in the Little Miami River near Yellow Springs, and others have been taken in that vicinity. Wood reported the species common in Lake Helen at Yellow Springs, Miami Twp. A specimen in the Dayton Public Library Museum bears the data: Yellow Springs, January 15, 1930. There is a notation that the specimen was found dead after a thaw. Conant (1938, p. 147) reported the species from Clifton, Miami Twp.

Amyda spinifera spinifera (Le Sueur), The Dayton Public Library Museum has a specimen with the data: Huffman Dam, Bath Twp., June 17, 1940.

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Sourcebook on Atomic Energy. *Samuel Glasstone.* D. Van Nostrand Co., New York. First Edition, 1950. 546 pp. $2.90.

This text was prepared by Dr. Glasstone under the direction of the technical information service of the AEC, and thoroughly reviewed by AEC personnel for correctness of material and security details prior to publication.

The aim of the author is to present a ready source of information on Atomic (Nuclear) Energy for the layman and for the physical scientist who has not specialized in nuclear physics. A comprehensive elementary survey of Atomic Energy is given in a semi-narrative form. For the most part, topics are grouped into chapters according to subject matter; the general arrangement of material is in historical sequence in so far as this is compatible with a logical presentation. The material is presented in such fashion that a minimum background in physics and mathematics is required for intelligent reading. Accuracy of the material presented is such that the Sourcebook should also be of interest to the physical scientist not specializing in atomic or nuclear physics, especially since most of the topics mentioned in the book are now assumed to be the entire sum and substance of contemporary physics by the general public. The subject index contains more than 1500 entries and greatly enhances the value of the book for reference work.

Atomic (Nuclear) Energy is playing an increasingly important part in our lives and it is important that all our citizens know something about its implications and possibilities. To date a general dissemination of reliable information on Atomic Energy has been meager due to security restrictions deemed necessary for national safety and language difficulties which arise between the technical man and the layman in any subject. The Sourcebook goes a long way toward solving the second difficulty.

EDWARD S. FOSTER, JR.

THE PROBLEM OF PUERTO RICAN MIGRATIONS TO THE UNITED STATES

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The migrations of the Puerto Rican natives to the United States, and more especially to New York City, have their roots deep in the economic and social development of the two regions. From this Island in the Caribbean with an area of 3,435 square miles and a population of approximately 2,211,000, New York City alone has had a yearly influx of more than 30,000 persons. As this is such a well-defined group of people coming from a compact area and migrating to an easily delineated region, it presents an excellent opportunity for a case study of a migration.

This paper is intended to examine three things: (1) the factors in Puerto Rico which have encouraged migration, (2) the economic and social status of the Puerto Rican in the United States, specifically in New York City, and (3) factors leading to a solution of the problem. Of necessity, some points will be discussed only briefly.

FACTORS IN PUERTO RICO ENCOURAGING MIGRATION

Never enjoying the advantages of statehood, or until recently, complete self-government, Puerto Rico has been all but ignored by the United States. Too valuable to be let go, not important enough to demand equal rights, not desiring to be independent, Puerto Rico suffers under the misunderstandings of American leadership.

Throughout the nineteenth century, Puerto Ricans had suffered under Spanish rule. With the beginnings of the twentieth century they looked to the aggressive American foreign policy sponsored by Theodore Roosevelt to alleviate the Island's distress and to begin an era of enlightenment and advancement.

In reviewing the history of the relationships of the two countries, one important factor, in respect to this paper, stands out—that is, the granting of citizenship by the United States to the mixed Spanish and Negro populations of the Island. For 30 years this act by the United States government had little noticeable effect, but today it is basic in an understanding of the migration problem. As citizens, Puerto Ricans can come to this country to settle. Without this single factor of citizenship, the problem of Puerto Rican migration into the United States would be non-existent.

The United States has made token advances toward developing Puerto Rico. Important advances in health and sanitation have been made; self-government has been encouraged; and social improvements have taken place. Some programs have back-fired. For example, the Insular Government has attempted better land-man ratios by limiting the size of sugar plantations. Unfortunately, as a result of confiscations, the Government now controls approximately six percent of the acreage and is one of the Island's largest cane producers.

There are few incentives to keep the Puerto Rican on his Island. Fifteen percent of the people are unemployed and many of the people are *underemployed*. The average wage is $350 a year—about $1.00 a day. The lack of a decent wage has lead to slum housing, disease, malnutrition, and filth. Only on the soil can the Puerto Rican hope to obtain a living but even there his efforts are frustrated by infertility and out-moded methods. The Puerto Rican has available weak soils, poor resources, and little power—except the power to reproduce at an incompatible rate.

A major factor in the wretched economic structure of the Island is the dominance of the sugar industry. Sugar *is* the economy. The industry is United States controlled and operated with huge plantations on the best Puerto Rican soil. Over fifty percent of the people live on these holdings and twenty-five percent are dependent upon the industry for work. With such a one-sided economy is it any wonder that Puerto Rico cannot advance?

The sugar industry is seasonal, and, as a result, for seven to nine months of the year the mass of the workers is unemployed. Only a limited amount of sugar may be refined in Puerto Rico due to trade restrictions, so that when the harvest is over a surplus of labor floods the market. There is no means of alleviating this problem, at present.

Actually, what is needed is some degree of industralization and /or a re-distribution of the land. Capital is required but is unavailable in Puerto Rico. Is it any wonder that the people seek "new worlds to conquer?"

During the regime of the Spanish, little was done to control deaths or births in the Island population. However, with diseases prevalent and sanitation lacking, the great number of deaths kept down the Island's population. In 1900, for instance, the population of Puerto Rico was 953,243 or 278 persons per square mile. Today, there are 626 persons per square mile.

Once the United States took control of the Island, health and sanitation improvements were undertaken. And a good job was done! So good, in fact, that the death rate was sharply reduced—and the natural factors that had kept the population fairly stable were eliminated. By improving sanitation, food, and health facilities, the U. S. has unintentionally aided the increase of population. Thus, Puerto Rico has one of the world's heaviest birth rates and a rapidly declining death rate. If the present birth rate of approximately 40 per 1,000 continues, the population will double in a quarter of a century.

What opportunity exists? There is about seven-tenths of an acre of arable land for each native. This figure is steadily diminishing with population pressure. The land-holders are big. The native must turn to upland areas or impoverished land to gain a living. Other than in handicraft industries there is little industrial employment. The Puerto Rican must have abandoned hope, for even hope needs feeding.

Educational facilities are lagging far behind population increases. In twenty years time the number of children increased by 120,000—an increase of 33 percent. During the same period, the children actually in school increased by 66 percent, but the number was still only 40 percent of the children. In the past few years more aggressive measures have been enforced so that educational facilities are being made available to greater numbers.

THE PUERTO RICAN IN THE UNITED STATES

We have reviewed briefly some of the important factors present on the Island that encourage migration. Now the question arises as to what the United States can offer these people.

Many of the first Puerto Ricans came to this country as contract workers. Of this group, many returned home but some remained in New York City to form the basis of a permanent colony. Of the contract workers brought to this country, about 96 percent returned to their native homes. With the nucleus formed, new migrants came to the United States in hopes of finding something better than was their lot on the Island. Today the total number of Puerto Ricans in New York City alone is about 350,000, according to Raymond Hilliard, Welfare Director of New York City. But the seriousness of the problem of immigration has diminished considerably since the years following the war. The net migration in 1948 and 1949 combined was 62,000—the same number as for 1947 alone (1947, 62,000; 1948, 34,000; 1949, 28,000). The gross migration is large but approximately

40 percent of all migrants eventually return to Puerto Rico. It is established, then, that two types of migrants are found, contract rural workers and urban dwellers. It is this latter type which has plagued New York City.

Contract agricultural labor has proved very satisfactory to farmers in the north-central states. A report from the New York Times of February 6, 1949, states that New York farmers were so pleased with the 1,400 laborers available in 1948 that double that number was wanted in 1949. Recently, too, Puerto Rican workers were called to Michigan in an emergency to help harvest Michigan's important sugar beet crop. With seasonal work the only type available in Puerto Rico, the contract work offered in the United States is a welcome source of employment. At the present time, Governor Marin has 200,000 Puerto Rican workers available for war-work in the United States when needed.

Many Puerto Ricans arrive in New York City as a result of letters written home from successful friends or relatives. No doubt, compared to the conditions on the Island, New York City's advanced program of social aids is in itself attractive enough to cause migrations. The Puerto Rican can hardly do worse by leaving his Island. The chance—and it is only that—that there is something better awaiting them has brought many of the migrants to the mainland.

What is often said to be the center of the settlement in New York City is so-called Spanish Harlem—an area one mile long and a block wide, bordered on the south by 96th Street, on the west by Central Park and 5th Avenue, on the east by 3rd Avenue and the Italian district, and on the north by 120th Street and Negro Harlem. The district is one of over-crowding, poverty, disease, and crime. This has been the story as it has appeared in our popular magazines—this is Puerto Rico transplanted in New York City. Yet, I wonder how many of the writers realize that both Brooklyn and the Bronx support, according to Manuel Cabranes, the Director of the Puerto Rican Employment Bureau in New York City, larger numbers of Puerto Ricans than does Manhattan, that these people live and work much the same as you and I, that they are respected by their neighbors, and enjoy life honestly? Too often the negative side is seen. The Puerto Ricans in Spanish Harlem are typical new settlers in New York. They are presenting no more of a problem than did the Italians, Poles, Jews, and Negroes of past years. In fact, if we are to believe labor leaders, the Puerto Rican is more welcome, relatively, as he has not lowered wages nor has he attempted to undermine the New York laborer's position.

A primary evil for the new migrants is the lack of decent housing. High-rent slums are typical of Harlem. Yet to these areas must the Puerto Rican go because he is an out-cast in other areas until he is properly adjusted or because of his dark skin. It is difficult to get "started" as high rents and food costs continue to keep living standards and savings down. New York officials hope to relieve the conditions by housing projects with rents costing $9.00 per room per month.

The Puerto Rican presents a serious employment problem. Seventy-nine percent of the immigrants reaching New York City have never done anything more skilled than simple hand-work and only nine percent of them have come to the city with either hope or promise of work. To complicate matters further literacy is low and the average schooling is 5.5 years. While the Puerto Ricans have not caused a drop in wage standards, many of them suffer, unknowingly, from below-minimum wages—the average wage is $28.05 a week. Those workers who complain are threatened with dismissal by their companies. Labor unions, relief organizations, and employment agencies have sought to solve this problem. Schooling has been supplied so that English and various trades may be learned. Such facilities offer the Puerto Rican hope that someday he will do other than his present menial tasks.

The influx of a mass of ignorant, unemployed, and under-fed citizens has caused

a serious relief and health problem to the City. When considering this aspect of Puerto Rican migration, we find estimates ranging from six percent to thirty percent of the population receiving relief from the City. Mr. Hilliard wrote, in a report on this problem to the Mayor of New York City, that ". . . The over-whelming majority of the Puerto Ricans are self-supporting, hard-working citizens of the City . . . contrary to frequent statements . . . only a very small minority of the Puerto Ricans (10 percent as compared to 4.2 percent for the rest of the population) are receiving public assistance in New York City . . ." The average Puerto Rican non-resident (a person living in New York City under one year's time) goes on relief later than the average non-resident. The Puerto Ricans wait 6.4 months whereas the non-resident average is 5.2 months. In this way the Puerto Rican has proved to many that his intentions are good—that public help is not the immediate end to his desires.

No doubt the Puerto Rican places an additional strain on health facilities in the City when he arrives. Rickets, tuberculosis, venereal diseases, and malnutrition are common. The cold weather of this latitude furthers respiratory diseases and increases health problems. However, the charge that Puerto Ricans come to New York City only for free health service is false. The Puerto Rican usually resides in the City longer than other non-residents before taking advantage of available hospital treatment.

SETTLEMENT OF THE PROBLEM

New York City has met the Puerto Rican immigration problem head-on. It is not a new problem but is, rather, a *re-newed* one. The problem is accentuated by the following factors: language handicap, unskilled workers, diseases and malnutrition, inadequate housing facilities, and employment disadvantages. There is, of course, an unwillingness by employers to hire these workers when better equipped workers are available. New York has the cooperation of the Puerto Rican government, the Puerto Ricans themselves, and of schools and civic groups, in the effort to remedy the situation.

One suggestion for limiting the problem in New York City is to reduce the number of immigrants coming into the City. If the immigrants could be channelled to other cities with promises of work, no one city's facilities would be taxed. Farm and industrial work could be opened up in other parts of the country if efficient ground-work were carried out—much of it by the Federal Government. In this way, New York thinks that the immediate problem of increasing population pressure could be relieved.

Other solutions lie in job-training programs, child and adult education, recreation and social programs, free health service, and other city or state aids. All cost money and place a tremendous burden on the City's budget but to solve the over-all problem such activities must be undertaken sooner or later. New York City must be shown to be no promised land. Education will answer this problem both in New York and in Puerto Rico.

In the words of Governor Marin, Puerto Rico is trying to solve its problems by ". . . increased agricultural production and industrialization . . . to keep up with the growing population . . . and to improve the standard of living of the common man to the point where, through education and other factors, the birth rate begins to decrease . . ."

Diversified industries are needed to provide full-year employment. Sugar's strong-hold on the agricultural economy must be broken. To bring new industries to the Island, Puerto Rico has set up a number of lucrative baits. One has been the government sponsorship of industries whereby the government operates new industries to prove their success whence they are turned over to interested private concerns. A second has been a 12-year tax exempt period in which new industries can develop and profit. Puerto Rico enjoys free trade with the United States

so that sale of manufactured goods can be successfully carried on in the United States.

Advantages for various industries are to be found. Industries such as textiles, rubber, glass, and furniture, can take advantage of raw materials, cheap labor, and available markets. New power facilities have been developed by the government to furnish cheap hydro-electric power.

The immediate problem of limiting migration can best be solved by improved living conditions. These should result from greater industrialization. This is what Puerto Rico hopes for. A more depressing note comes to our attention, however, as we realize that industrialization will help for a time but the country cannot benefit until the excessive birth rate can be brought under control. Any future policy of the government must give much consideration to education. For in education lies a hope for the development of a more stable birth rate. Only with a stable population can Puerto Rico attract industries and hold on to its people. Here, perhaps, is the key to Puerto Rico's economic success and a solution to the problem of Puerto Rican migrations.

Culture Worlds. *Richard Joel Russell and Fred Bowerman Kniffen.* The Macmillan Company, New York. First Edition. 1951. xviii+620 pp. $6.00.

This publication presents a new and different approach to college geography. It may well be considered as a textbook for an introductory course by anyone who feels geography students should know something about the countries of the earth before they undertake a study of the more specialized fields of physical or economic geography. The text is a regional geography of the earth based on "culture" worlds or regions, of which the authors recognize seven major ones, namely, European, Oriental, Dry, African, Polar, American, and Pacific worlds. There is a general introductory discussion of each culture realm and then its principal countries are considered individually.

The emphasis throughout the book is on culture. The authors have skillfully blended geographical and historical factors in their interpretation of the culture of each of these major worlds and their constituent realms. Of special interest is the discussion of "shatter belts" found particularly in Europe and Asia. These are the areas where cultures meet, mingle and conflict, and where small buffer states result.

The publication is intended for college freshmen and admirably suited to their needs. It is not encyclopedic in detail nor overburdened with statistical tables but strewn lavishly with nearly two-hundred simple maps and exceptionally well-chosen pictures. An improvement in the text would result from a more extensive bibliography, although the authors may consider the present one adequate to the publication's intended use.

LOWRY B. KARNES

A SYSTEMATIC STUDY OF THE MAIN ARTERIES IN THE REGION OF THE HEART—AVES XVIII.

PSITTACIFORMES, PART I[1]

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It is important to point out that the nomenclature and species designation of many of the earlier writers, particularly those writing on avian morphology, have used names which cannot be truly identified in a great many instances, or only with considerable difficulty and uncertainty. Furthermore, due to more recent taxonomic studies, many species have been shifted from one family or even order to another and, in addition, many species and even genera have been regrouped within the orders.

A consideration of present taxonomic positions in view of anatomical evidences should aid in a better understanding of specific and family relationships. Important morphologic deviation of species within any genus should be adequate basis for reassignment of the aberrant forms.

Garrod (1873) has pointed out that among the Psittaciformes, a wide variety of arrangements of the carotid arteries can be observed. Garrod's species designations, however, do not always directly correspond with the names which are designated by Peters (1937). As a result, Garrod's identifications cannot be regarded as altogether accurate in light of present-day nomenclature. It will suffice, however, for discussions in which approximate species designations are satisfactory.[2]

Strigops habroptilus G. R. Gray, *Chalcopsitta cardinalis* (G. R. Gray) (*Lorius cardinalis*), *Eos histrio histrio* (P. L. S. Müller) (*Eos indica*), *Kakatoe roseicapilla roseicapilla* (Vieillot) (*Eolophus roseicapillus*), *Glossopsitta concinna* (Shaw) (*Trichoglossus concinnus*), *Nymphicus hollandicus* (Kerr) (*Calopsitta novaehollandiae*), *Prioniturus sp.*, *Psittacula krameri manillensis* (Bechstein), *Psittacula alexandri alexandri* (Linnaeus) (*Palaeornis alexandri*), *Psittacula cyanocephala cyanocephala* (Linnaeus), (*Aprosmictus scapulatus*) is probably *Alisterus scapularis scapularis* (Lichtenstein), *Agapornis roseicollis* (Vieillot), *Loriculus sp.* is (*Loricullus sp.*), *Neophema pulchella* (Shaw) (*Euphema pulchella*), *Neophema splendida* (Gould) (*Euphema splendida*), *Neophema bourkii* (Gould) (*Euphema Bourkii*), and *Melopsittacus undulatus* (Shaw) are reported to be "aves bicarotidinae normales" (2 & 3) with both left and right internal carotid arteries entering the hypapophysial canal (fig. 1).

In *Nestor notabilis* Gould, (*Nestor hypopolius*—correct accepted name as yet undetermined), *Lathamus discolor* (White), *Ara macao* (Linnaeus), *Aratinga holochlora holochlora* (Sclater) (*Conurus holochlorus*), *Aratinga jandaya* (Gmelin) (*Conurus jendaya*), *Aratinga canicularis canicularis* (Linnaeus) (*Conurus petzi*), *Pyrrhura cruentata* (Wied) (Conurus cruentatus), *Forpus passerinus flavissimus* Hellmayr (*Psittacula passerina*), *Brotogeris tirica* (Gmelin) (*Brotogerys tiriacula*), *Brotogeris versicolurus versicolurus* (P. L. S. Müller) (*Brotogerys virescens*), *Brotogeris chrysopterus tuipara* (Gmelin) is the probable designation for (*Brotogerys tui*), *Pionites melanocephala melanocephala* (Linnaeus) (*Caïca melanocephala*), *Pionus*

[1]Contribution of the Blue Sea Lake Biological Laboratory, Messines, P. Q.

[2]Generic and specific names followed by the authority's name are in accordance with "Check-list of Birds of the World," Vol. III, by J. L. Peters. Generic and specific names in brackets are those of Garrod (1873).

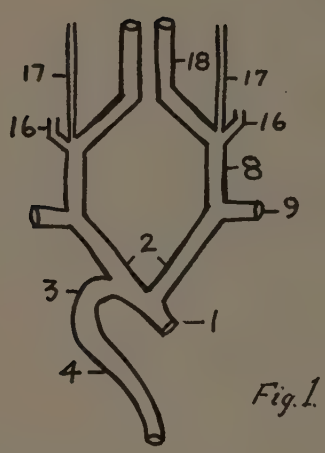

Fig. 1.

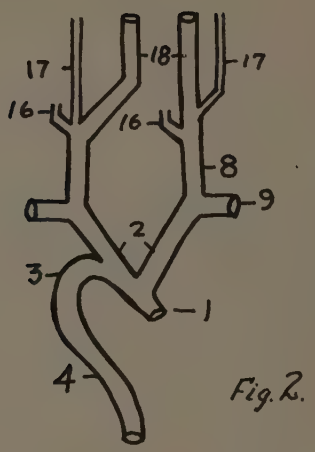

Fig. 2.

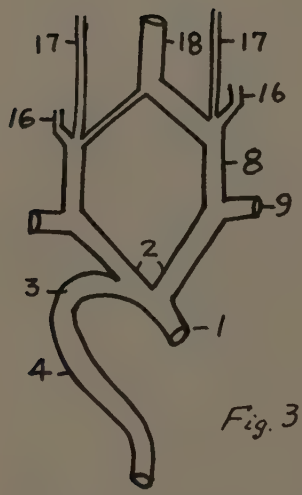

Fig. 3

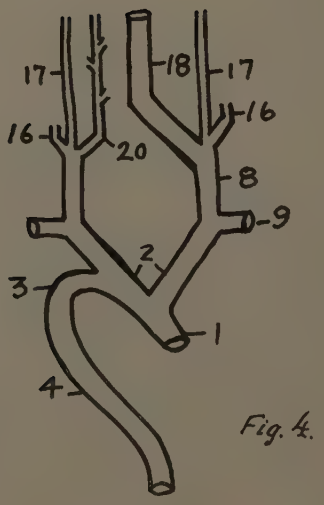

Fig. 4.

FIGURES 1–4. Ventral view of main arteries in neck and thorax.
FIGURE 1. "aves bicarotidinae normales"—*Melopsittacus undulatus.*
FIGURE 2. "aves bicarotidinae abnormales"—*Ara macao.*
FIGURE 3. "aves conjuncto-carotidinae" (modification)—*Kakatoe s. sulphurea.*
FIGURE 4. "aves laevo-carotidinae"—*Kakatoe sulphurea citrino-cristata.*
(Figures 2, 3, and 4 adapted, with modifications, after Garrod.)

menstruus (Linnaeus), *Amazona festiva festiva* (Linnaeus) (*Chrysotis festiva*), *Amazona ochrocephala oratrix* Ridgway (*Chrysotis levaillantii*), *Amazona ochrocephala ochrocephala* (Gmelin) (*Chrysotis ochrocephala*), (*Conurus xantholaemus*) is undetermined but is probably *Amazona ochrocephala xantholaema* Berlepsch, *Psittacus erithacus erithacus* Linnaeus, *Platycercus eximius eximius* (Shaw), *Platycercus adsciyus palliceps* Lear (*Platycercus pallidiceps*), *Northiella haematogaster haematogaster* (Gould) (*Psephotus haematogaster*), *Cyanoramphus novaezelandiae novaezalandiae* (Sparrman) (*Cyanorhamphus novae-zealandiae*), and *Cyanoramphus auriceps auriceps* (Kuhl) (*Cyanorhamphus auriceps*) the right internal carotid artery enters the hypapophysial canal while the left internal carotid artery is superficial and passes anteriorly along the left side of the neck (fig. 2), according to Garrod (1873).

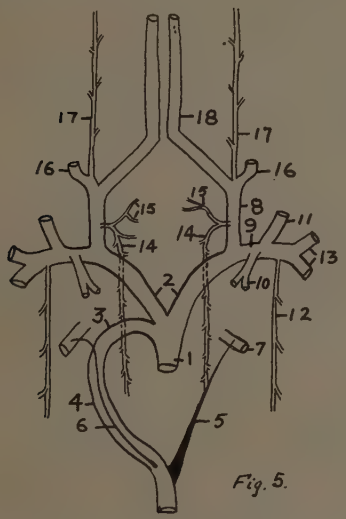

Fig. 5.

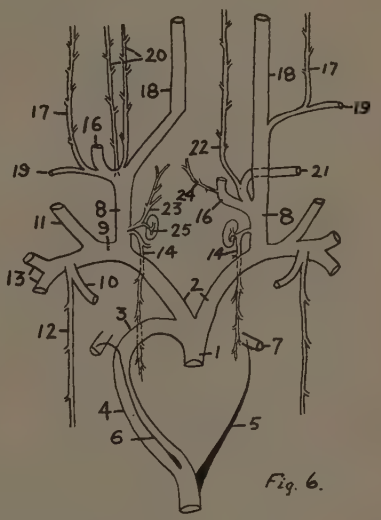

Fig. 6.

FIGURES 5–6. Ventral view of main arteries in neck and thorax.
FIGURE 5. *Agapornis personata.*
FIGURE 6. *Ara ararauna.*

KEY TO NUMBERS IN FIGURES

1. aortic root; 2. innominate artery; 3. right systemic arch; 4. right radix aortae; 5. ligamentum aortae; 6. ligamentum botalli; 7. pulmonary artery; 8. common carotid artery; 9. subclavian artery; 10. coracoid major artery; 11. axillary artery; 12. intercostal artery; 13. pectoral arteries; 14. ductus shawi; 15. syringo-tracheal arteries; 16. vertebral artery; 17. superficial cervical artery; 18. internal carotid (trunk) artery; 19. scapular artery; 20. ascending oesophageal artery (right); 21. secondary axillary artery; 22. ascending oesophageal artery (left); 23. right basi-oesophageal artery; 24. left basi-oesophageal artery; 25. thyroid artery.

According to Garrod (1873), Meckel reported that the right internal carotid artery is very small and fuses with the left internal carotid in *Kakatoe sulphurea sulphurea* (Gmelin), with the vessel thus formed entering the hypapophysial canal and then passing anteriorly to the head. Such a condition is refered to as "aves conjuncto-carotidinae" (fig. 3) and is occasionally encountered in other orders of birds, especially in the Ciconiiformes (Glenny, 1945). Finally, Garrod reported that in *Kakatoe galerita galerita* (Latham) and *Kakatoe sulphurea citrino-cristata*

(Fraser) (*Cacatua cristata*) the left internal carotid artery alone enters the hypapophysial canal to carry the blood supply to the head (fig. 4).

The present study in part confirms some of the findings of Garrod, and adds further to our present knowledge of the arterial arrangements in the neck and thorax of birds.

An excellent study of the cervical and thoracic arteries in two species of parrots (*Psittacula c. cyanocephala* and *Psittacula krameri manillensis*) was carried out by Bhaduri and Biswas (1945). In this study, the writers found the two paroquets to be "aves bicarotidinae normales" and to present both the ligamentum aortae and ligamentum botalli, as well as left and right ascending oesophageal arteries. While this latter condition is not too frequently reported in the literature, it is undoubtedly present in a great many species of birds (Glenny, 1943–1948).

MATERIALS

Single specimens of *Vini australis* (Gmelin) (USNM #319754), *Ara ararauna* (Linn.) (ROMZ), *Brotogeris jugularis jugularis* (P. L. S. Müller) (USNM #343969), *Agapornis personata* Reichenow (USNM #290557), and *Melopsittacus undulatus* (Shaw) (USNM #322002) were studied. The specimens used in this study were obtained from the United States National Museum and the Royal Ontario Museum of Zoology.

OBSERVATIONS

Melopsittacus undulatus, *Agapornis personata*, and *Vini australis* are "aves bicarotidinae normales." The common carotid (8) gives rise to the ductus shawi (14) and then divides to give rise to the vertebral (16), superficial cervical (17), and internal carotid (trunk) arteries (18). The subclavian (9) gives rise to the coracoid major (10), axillary (11), intercostal (12), and two pectoral (13) arteries in order, in both *Melopsittacus* and *Agapornis*, while in *Vini* the axillary appears to arise medial to the coracoid major.

In *Agapornis* and *Vini*, both the ligamentum aortae (5) and the right ligamentum botalli (6) are present and prominent, while in *Melopsittacus* only the ligamentum aortae was observed to be present. The right superficial cervical artery (17) appears to serve as an ascending oesophageal artery.

Ara ararauna (fig. 6) and *Brotogeris jugularis* are similar in arterial arrangement in several respects. The right internal carotid (trunk) artery alone enters the hypapophysial canal, while the left carotid passes anteriorly and superficially along the left side of the neck. Both the ligamentum aortae and ligamentum botalli are present in *Ara*, while the ligamentum aortae alone was observed in *Brotogeris*.

The common carotid gives rise to the ductus shawi, the superficial cervical, and vertebral arteries before giving rise to the internal carotid (trunk) artery. The subclavian gives off the coracoid major, axillary, and two pectoral arteries in *Brotogeris jugularis*.

In *Ara*, the right common carotid sends off the ductus shawi, basi-oesophageal, superficial cervical, vertebral, ascending oesophageal, and internal carotid arteries; the left common carotid gives rise to the vertebral, superficial cervical, and superficial left internal carotid arteries. A scapular artery arises as a branch of the superficial cervical arteries on either side. The left vertebral artery gives rise to a secondary axillary artery (21), from the base of which vessel the left ascending oesophageal artery (22) arises, and a basi-oesophageal artery (24). The thyroid gland is supplied by a short thyroid artery which arises from the common carotid or one of its branches. The subclavian artery gives rise to the axillary, coracoid major, and two pectoral arteries in order. The intercostals (12) may arise from the coracoid major near its origin or from the subclavian just lateral to the coracoid major artery.

DISCUSSION

Beddard (1898) attempted to assign the Psittaciformes to two families on the basis of the arrangement of the carotid arteries, along with other major anatomical features. Except for the Cacatues or Kakatoes, the arrangement of subfamilies appears to fit into the anatomical arrangement fairly well, provided Beddard's criteria are employed. Peters' arrangement (1937), however, does not follow or correspond with the Beddard system. A comparison of the two taxonomic systems follows, and is accompanied by changes in generic names to correspond with Peters (1937).

BEDDARD	PETERS	Subfamily
Family I. PALAEORNITHIDAE (2 carotids enter hypapophysial canal):		
Subfamily 1. **Palaeornithinae**		
Palaeornis	*Psittacula*	**Psittacinae**
Eclectus	*Lorius*	"
Aprosmictus	*Psittacula*	"
Eos	*Eos*	**Loriinae**
Tanygnathus	*Tanygnathus*	**Psittacinae**
Prioniturus	*Prioniturus*	"
Psittinus	*Psittinus*	"
Loriculus	*Loriculus*	"
Trichoglossus	*Glossopsitta*	**Loriinae**
Lorius	*Domicella*	"
Sunfamily 2. **Cacatuinae**		
Calopsitta	*Nymphicus*	**Kakatoeinae**
Calyptorhynchus	*Calyptorhynchus*	"
Licmetis	*Kakatoe* (Subgenus *Licmetus*)	"
Eolophus	*Kakatoe* (Subgenus *Eolophus*)	"
Cacatua	*Kakatoe* (Subgenus *Kakatoe*)	"
Subfamily 3. **Stringopinae**		
Stringops	*Strigops*	**Strigopinae**
Euphema	*Neophema*	**Psittacinae**
Geopsittacus	*Geopsittacus*	"
Melopsittacus	*Melopsittacus*	"
Agapornis	*Agapornis*	"
Family II. PSITTACIDAE (left carotid is superficial; right carotid enters hypapophysial canal):		
Subfamily 4. **Arinae**		
Ara	*Ara*	**Psittacinae**
Conurus	*Aratinga*	"
Bolborhynchus	*Bolborhynchus*	"
Caïca	*Pionites*	"
Psittacus	*Psittacus*	"
Poeocephalus	*Poicephalus*	"
Nestor	*Nestor*	**Nestorinae**
Subfamily 5. **Pyrrhurinae**		
Pyrrhura	*Pyrrhura*	**Psittacinae**
Lathamus	*Lathamus*	**Loriinae**
Coracopsis	*Coracopsis*	**Psittacinae**
Pyrrhulopsis	*Prosopeia*	"
Subfamily 6. **Platycercinae**		
Platycercus	*Platycercus*	**Psittacinae**
Psephotus	*Psephotus*	"
Cyanorhamphus	*Cyanoramphus*	"
Psittacula	*Forpus*	"
Subfamily 7. **Chrysotinae**		
Chrysotis	*Amazona*	**Psittacinae**
Pionus	*Pionus*	"
Brotogerys	*Brotogeris*	"
add: *Vini australis* (aves bicarotidinae normales)		**Boriinae**

While in most orders of birds, both ordinal and family arrangement-patterns of the cervical and thoracic arteries can be observed, no single family pattern can be determined, and in so far as subfamily characteristics are concerned, based on Peters (1937), only the Strigopinae, Nestorinae, and Micropsittinae can be considered to offer any chance of characteristic arterial arrangement-patterns. Furthermore, the Kakatoeinae are reported to present at least three different arrangements of the carotid arteries alone (normal bicarotid, conjugate carotid, and "aves laevocarotidinae"). The Psittacinae likewise present wide variation in arrangement of the carotids, while the Loriinae present at least two major carotid arrangements.

As a result of the extreme complexity of structure in this order of birds, it is little wonder that they provide considerable difficulty in properly assigning group relationships. It is suggested that a reconsideration of this order be based more on skeletal structure, with particular emphasis on the bones of the skull and palate, musculature of leg and wings, and other soft viscera, including the aortic arch derivatives, as well as the other external features which are commonly used as bases for classification.

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Applied Statistics. *Forrest R. Immer.* Burgess Publishing Co., Minneapolis. ii+157 pp. $4.00.

This book contains an exposition of the use of analysis of variance methods, particularly of those useful in analyzing data of agronomic experiments. The text, published posthumously, is based upon lectures given by Dr. Immer between 1935 and 1946 at the University of Minnesota.

The presentation proceeds from a discussion of a randomized block experiment, through increasingly complex designs, to triple lattice and balanced incomplete block experiments. Emphasis rests on the procedure of analysis, not on the theoretical basis for analysis. The desirability of testing for homogeneity of variance before pooling to estimate the error variance is not emphasized. Nor is the user of analysis of variance methods adequately warned about other assumptions his data and experiments should fulfill. The treatment of discrete variables receives only scant attention, there being one chapter on the χ^2 test of independence in 2 x 2 contingency tables. Despite these limitations, practicing statisticians will find this a valuable book to possess.

The text is marred by several typographical errors, a few of which will definitely impede a beginner's understanding. An example occurs on page 8 where the variance is defined as $s^2 = S(x - \bar{x})^2$ instead of $s^2 = S(x - \bar{x})^2/(N - 1)$.

E. L. Green.

THE AESCULUS-FEEDING SPECIES OF *EXARTEMA* WITH DESCRIPTION OF A NEW SPECIES

(Lepidoptera, Eucosmidae)

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Salem Pike, Mt. Washington, Cincinnati 30, Ohio

In most groups of Lepidoptera, the genitalia, both male and female, furnish constant and reliable characters for species differentiation. In many instances, they will separate species otherwise indistinguishable. This is in general as true for the Eucosmidae and for the genus *Exartema* as for any group. Here, while differences may be slight and related species not easily separated by genitalic characters (compare the harpes in several closely related species, and the similarity in female genitalia of species easily separated by other characters, such as *Exartema ochrosuffusanum* Heinrich and *E. hippocastanum* Kearfoot, figs. 4, 7), these structures are apparently constant for the species. It was therefore a considerable surprise to discover a species in which the variation in certain characters of the female genitalia within the species was greater than the differences between species in which these characters are constant for the species.

This new species, herein described as *Exartema appalachianum*, and three previously described species of *Exartema*, *E. sciotanum* Heinrich, *E. hippocastanum* Kearfott, and *E. ochrosuffusanum* Heinrich are leaf-rollers of various species of *Aesculus* .(buckeye). In larval habits, they exhibit a characteristic common to many species of the genus, viz., that of cutting the petiole of a leaf causing it to droop and wilt. In the Aesculus-feeding species, the larva feeds at first within a folded young wilted leaflet, later cutting the petiole of a second leaflet, which is then folded within a third leaflet; sometimes the entire compound leaf may be involved in the feeding process.

Larvae collected on *Aesculus octandra* Marsh. in Carter County, Kentucky, in April, 1938, under rearing record B.1611, produced a series of moths, very variable in wing markings (figs. 9, 10), but obviously different from either *E. sciotanum* or *ochrosuffusanum*, both of which were known to be feeders on *Aesculus*. The possibility that these specimens might be *E. hippocastanum*, in spite of apparent disagreement with the description of that species, led to the sending of several specimens to Mr. Carl Heinrich of the United States National Museum, who wrote in reply:

"They are close to both *hippocastanum* and *sciotanum*. Their male genitalia could pass for those of either species. Their female genitalia, however, differ in the shape of the projecting lobes on the sides of the genital opening from those of either *sciotanum* or *hippocastanum*. The dark markings on fore wing are considerably darker and more sharply defined in your unnamed species than those of *sciotanum;* and the paler areas of fore wing are darker than those of *hippocastanum*. I think your specimens represent a new species."

In a second series of moths (B.1700 and B.1704) reared on *Aesculus octandra* from Pulaski and Whitley counties in southern Kentucky, and agreeing with the Carter County series in wing markings, the female genitalia are essentially as in the Carter County series (fig. 1). A third series (B.1875) on *Aesculus octandra* from Paintsville, Kentucky (southeast of Carter County), although in wing markings indistinguishable from the first two series, is strikingly different in female genitalia (fig. 2). In two series from the Tennessee side of the Great Smoky Mountains (B.1714, B.2135), there is a further variation in the shape of the

projecting lobes of the female genitalia (fig. 3); all specimens under B.2135 are darker in wing color than any of the Kentucky specimens, and although the wing markings are variable, there is less tendency for the median band to break up.

In this instance, genitalic characters, if used, would divide into several species series which are inseparable on the basis of wing markings. It is suggested that we are here dealing with a case of introgressive hybridization resulting in increased variability, although it is not now possible to determine the original parentage.

Exartema appalachianum n. sp.

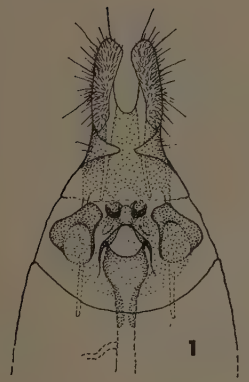
Antennae ochreous to ochreous-fuscous, darker above; first segment with a dark brown or fuscous spot above, second segment blackish fuscous with the dark shade spreading along the stalk in the darker specimens. Palpi whitish ochreous; second segment with brownish or fuscous shading toward apex, and two brown or blackish fuscous spots on outer side; third segment blackish fuscous, with extreme tip whitish. Head ochreous-tawny or ferruginous-brown, with more or less fuscous shading; on each side of front a blackish fuscous patch. Thorax ferruginous-ochreous to brownish fuscous, with transverse darker bars; tips of tegulae pale.

Fore wing (figs. 9, 10) with the basal area, median band, pretornal patch, outer costal spots and subapical bar dark brown in most specimens, black in the series B.2135, more or less overlaid with dull ochreous, reddish ochreous, or ferruginous brown. The basal area is more or less broken with transverse leaden metallic lines, interlined with fine fuscous lines, especially toward costa, but its outer margin, although irregular and sometimes indistinct near costa, is always complete, i.e., the basal area is not longitudinally divided. Antemedian and postmedian pale areas leaden metallic with a faint rosy tinge in the ferruginous-tinted specimens; with blackish or reddish fuscous interlines. The antemedian pale area sometimes broadens and forks toward dorsum thus cutting off from the basal area a triangular patch, which may be reduced to a mere dorsal dash (fig. 9). Median band with both teeth short and widely separated, the upper narrower, the lower, broader and bluntly rounded; at the base of the sinus between them a circular more or less clearly defined patch, separated by a narrow line from the band itself. Below the teeth the median band is deeply indented or even separated from the costal half of the band by an intrusion of the pale postmedian area; dorsal portion of the band variously shaped and sometimes abruptly contracted near dorsum to a mere stalk. The median band may be broken up by intrusions of the pale areas, and is then represented by the separated costal part with the upper tooth, the detached lower tooth, and a dorsal patch (fig. 9). This variation is irrespective of sex, but occurs more commonly in the female. Pretornal patch and subapical bar variable in shape. Cilia tawny to ferruginous-fuscous, with a dark basal line and blackish fuscous bars, the broadest at apex and opposite the end of the subapical bar.

Hind wing pale brownish fuscous, blackish fuscous in series B.2135, becoming paler toward costa and base; cilia whitish ochreous, with more or less fuscous shading, especially at apex and tornus, and a dark basal band. Underside of hind wing whitish ochreous, more or less shaded with fuscous, especially toward costa and apex, the fuscous scales arranged in transverse bars between the veins. Only in the darkest specimens are the bars obscured by fuscous shading. In male, a notch at vein 1b, and slight notches at veins 1c and 5.

EXPLANATION OF FIGURES

1. Female genitalia of *Exartema appalachianum* n. sp., paratype, series B.1611.
2. Female genitalia of *Exartema appalachianum* n. sp., paratype, series B.1875.
3. Female genitalia of *Exartema appalachianum* n. sp., paratype, series B.2135.
4. Female genitalia of *Exartema hippocastanum* Kearfott, paratype, Black Mountains, North Carolina.
5. Female genitalia of *Exartema sciotanum* Heinrich, Cincinnati, Ohio (type locality).
6. Harpe of *Exartema appalachianum* n. sp., paratype, series B.1611.
7. Female genitalia of *Exartema ochrosuffusanum* Heinrich, Cincinnati, Ohio (type locality).
8. Map showing geographic distribution of the Aesculus-feeding species of *Exartema*.
9. Fore wing of *Exartema appalachianum* n. sp., allotype, female.
10. Fore wing of *Exartema appalachianum* n. sp., type, male.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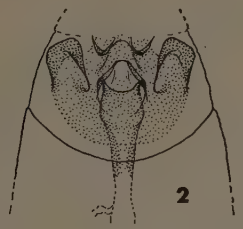
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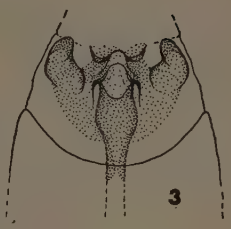
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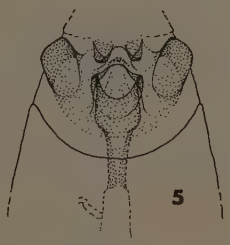
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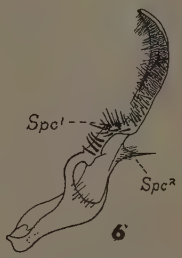
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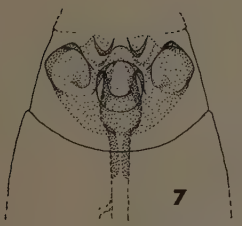
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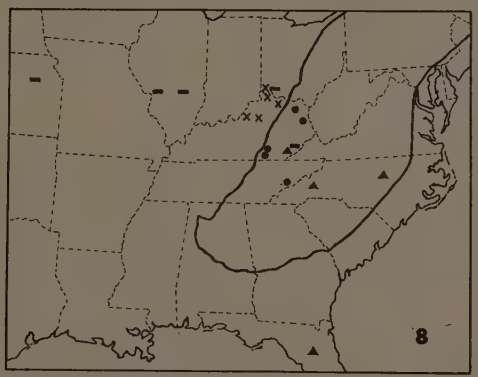
8
appalachianum
sciotanum
hippocastanum
ochrosuffusanum
Boundary of Appalachian Highlands

9

10

Expanse: 21 to 22 mm.

Male genitalia: harpe (fig. 6) with spine cluster (Spc^2) close to cucullus; spine cluster (Spc^1) almost identical with that of *E. hippocastanum*.

Female genitalia (figs. 1, 2, 3): variable in the shape of the projecting lobes on either side of the ostium. In series B.1611 (fig. 1) and in series B. 1704, these lobes with a lateral bulge and a more or less truncate produced apical lobe; in series B.2135 (fig. 3), lateral bulge absent, and apical lobes rounded; in series B. 1875 (fig. 2) the entire projecting lobe is rectangular in outline, but rises to a broadly rounded apex. Compare this with figure 5 (*sciotanum*) which it closely resembles but in which the projecting lobe tapers to a sharp ridge along the apex.

Type.—♂, Carter City, Carter County, Kentucky, under rearing record B.1611, imago May 28, 1938; in Coll. A. F. Braun. (Wing pattern, fig. 10.)

Allotype.—♀, Carter City, Carter County, Kentucky, under rearing record B. 1611, imago May 27, 1938; in Coll. A. F. Braun. (Wing pattern, fig. 9.)

Paratypes.—16 ♂, 20 ♀. Under rearing record B.1611, Carter City, Carter County, Kentucky, 4 ♂, 6 ♀, imagoes May 24 to June 2, 1938 (3 ♂, 4 ♀ in Coll. A. F. B.; 1 ♂, 2 ♀, in the United States National Museum); under B.1700, Cumberland National Forest, Pulaski County, Kentucky, 1 ♀, imago May 24, 1939; under B.1704, Buck Branch of Jellico Creek, Whitley County, Kentucky, 2 ♂, 2 ♀, imagoes May 27 to June 1, 1939; under B.1875, Paintsville, Johnson County, Kentucky, 7 ♂, 4 ♀, imagoes May 22 to May 25, 1941; under B.1714 and B.2135, in the valley of Le Conte Creek, Great Smoky Mountains, Tennessee, 3 ♂, 7 ♀, imagoes May 30, 1939, and May 29, 30, 1950. Paratypes will be deposited in the United States National Museum, the American Museum of Natural History, and the Academy of Natural Sciences of Philadelphia.

All of the specimens were reared on *Aesculus octandra* Marsh., the larva at first feeding within a folded and wilted leaflet, later cutting the petiole of a second leaflet, which together with the first leaflet is rolled within a third leaflet; on smaller leaves, the entire compound leaf is involved in the feeding, but the rolled leaves are only partially consumed. Larvae may be found in the latter half of April and in early May, depending on latitude and altitude, with the emergence of the imagoes in May and early June.

It will be noticed from the distribution map (fig. 8) that all of the localities are within the boundary of the Appalachian Highlands.

In spite of the extreme variability in wing markings, there is a general aspect by which individuals of the species can be associated together. In this species, characters of the female genitalia offer little assistance, because of the variation from series to series; male genitalia of related species are closely similar.

The genitalia illustrated in figure 2 suggest, by the general shape of the lateral lobes, a relationship to *E. sciotanum*. In this series (B.1875) ,the duller, more ochreous color of the overscaling of the dark markings approaches that of *E. sciotanum*. The breaking up of the median band with the resulting less sharp definition of its components, and the paler median longitudinal shade (fig. 9)—a variation found in all the series—also suggests a close relationship to *E. sciotanum*. These features, together with the variability of *E. appalachianum* in female genitalic characters, suggested hybrid origin of *E. appalachianum* with the possibility of *E. sciotanum* as one of the original parents, and its later segregation into a distinct species, not yet stabilized.

Exartema sciotanum Heinrich

Exartema sciotanum Heinrich, 1923, Proc. Ent. Soc. Wash. 25: 115; 1926, U. S. N. M. Bull. 132: 147.

This species may be separated from both *E. appalachianum* and *E. hippocastanum* by the less sharply defined dark markings, their dull ochreous shading and paler color, and especially by the fine ochreous line separating the upper and lower teeth of the median band. In female genitalia (fig. 5), the large lateral lobes of the genital plate, with *sharp-ridged* apex distinguish this species.

All of the localities from which *E. sciotanum* is known are west of the Appalachian Plateau (fig. 8) although the eastern-most locality for the species (Bracken County, Kentucky) lies not far to the west of the plateau escarpment. There appears to be no overlapping of ranges of *E. sciotanum* and *E. appalachianum*.

Both *Aesculus octandra* Marsh. and *Aesculus glabra* Willd. are food plants of *E. sciotanum*, the latter most commonly and in most parts of its range the only food plant.

Exartema hippocastanum Kearfott

Exartema hippocastanum Kearfott, 1907, Bull. Amer. Mus. Nat. Hist. 23: 155; Heinrich, 1926, U. S. N. M. Bull. 132: 149.

Originally described from a series reared on *Aesculus* (probably *A. octandra*), Black Mountains, North Carolina, the known range of this species (fig. 8) has been extended to include a locality on the Piedmont (Durham, North Carolina), a locality on the Coastal Plain (Gainesville, Florida), and a locality in the Cumberland Mountains (Gilley, Letcher County, Kentucky, June 13, 1933; A. F. Braun). The Durham, N. C. specimen (a female) was reared on *Aesculus neglecta* Lindl. (Durham, N. C., 26 May, 1942. Wm. Haliburton coll.). This specimen, loaned to the writer for examination through the courtesy of the United States National Museum and Mr. J. F. Gates Clarke, shows the rosy or ferruginous pale areas of the fore wing strongly contrasting with the rich brown or reddish markings, and the longitudinally divided basal area, i.e., the outer boundary of this area broken, its segments separated. In comparison to *E. appalachianum*, it is a somewhat broader-winged species. The hind wings are brown (lacking the strong fuscous admixture of *appalachianum*). The underside of the hind wings in costal and apical areas is mottled with fuscous shading, not conspicuously arranged in transverse bars, as in *appalachianum*. The Cumberland Mountains specimen, a flown female, agrees exactly in genitalic characters with the type series from North Carolina. However, the pale areas of the fore wing are much darker and not strongly contrasting with the dark markings as in typical specimens, although the rosy tint is discernible. Thus it approaches, in color and markings, specimens of *appalachianum* in which the median band is not broken up. The outer margin of the antemedian pale area, although oblique in the cell, lacks the pronounced projection toward the intrusion from the postmedian pale area below the teeth. The outer margin of the basal dark area is broken at the points which define the longitudinal divisions in typical *hippocastanum*. In color and in mottling of the underside of the hind wing, it agrees with typical *hippocastanum*.

In the female genitalia (fig. 4 from a slide of a paratype, Black Mountains, North Carolina, loaned by the American Museum of Natural History) the lobes on either side of the ostium are short, thus differing from *sciotanum* and any of the variations of *appalachianum*, although almost identical with the corresponding structures in *ochrosuffusanum* (fig. 7).

Exartema ochrosuffusanum Heinrich

Exartema ochrosuffusanum Heinrich, 1923, Proc. Ent. Soc. Wash. 25: 117; 1926, U. S. N. M. Bull. 132: 150.

This species is easily recognized by the sienna yellow or pale brown color of the partially obliterated markings, and little contrast between the dark markings and the paler areas, except for the purplish suffusion due to the metallic scaling.

Based upon available records this is the most widely distributed of the Aesculus-feeding species (fig. 8), and the only species to occur both west of the Appalachian Highlands and within that area (note locality in the Cumberland Mountains at the eastern border of Kentucky). In the western parts of its range, the food plant is doubtless *Aesculus glabra*, in the Cumberland Mountains locality, *Aesculus octandra*.

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